NIPIGON RIVER: DEVELOPMENT OF A WATER MANAGEMENT PLAN

DRAFT OPTIONS REPORT

TECHNICAL REPORT No. 18

May, 1993

RAP

NORTH SHORE
OF LAKE SUPERIOR
REMEDIAL ACTION PLANS

NIPIGON RIVER DEVELOPMENT OF A WATER MANAGEMENT PLAN

DRAFT OPTIONS REPORT

Prepared for:

Nipigon River Management Committee

The Study Team:

Atria Engineering Hydraulics Inc.
in association with
Ecological Services for Planning Ltd.
David Evans and MWR & Associates
Alan A. Smith Inc.
E.D. Soulis & K. Ponnambalam

May, 1993

FORWARD

In response to increased demands being placed on the Nipigon River watershed, the Ministry of Natural Resources, Ontario Hydro, The Nipigon Bay Remedial Action Plan (RAP) Team, the Nipigon RAP Public Advisory Committee and the Ministry of Environment and Energy formed the Nipigon River Management Committee in 1990.

Habitat restoration is an important goal of the four North Shore of Lake Superior RAPs. The effect water fluctuations and minimum flow rates in the Nipigon River are having on Nipigon Bay are specific concerns identified by the Nipigon Bay RAP Public Advisory Committee. Nipigon Bay is one of 43 areas of concern around the Great Lakes for which water remedial action plans are being developed to address specific environmental problems and impaired beneficial uses.

Therefore, the goal of this project is to establish, through public involvement, a management option that will reduce the impacts Ontario Hydro's hydroelectric dams on the Nipigon River are having on the Lake Nipigon/Nipigon River watershed, particularly the Nipigon River fishery.

This project is jointly funded by the federal Government's Great Lakes Cleanup Fund and each of the agencies on the Nipigon River Management Committee. It is one of eight habitat restoration projects that have been initiated since 1990 to restore self-sustaining fish stocks in Nipigon Bay.

Environment Canada's Cleanup Fund provides funds to help develop and demonstrate technologies and remedial programs to meet federal responsibilities in Canadian areas of concern throughout the Great Lakes Basin.

ERRATA

1) FORWARD, para. 1, line 2 - should read "...the Nipigon Bay RAP Public Advisory Committee..."

2) ACKNOWLEDGEMENTS - should read "Bill Hudson"

3) ACKNOWLEDGEMENTS and TABLE OF CONTENTS; page header - should read "Development of a Water Management Plan"

4) List of Photographs, Photo 3.3.7c - should read "Damaged boat dock at Macdiarmid, Lake Nipigon, October, 1992 (recorded water level 260.23 m to 260.43 m)

5) page 1, Section 1.1, para. 3, line 1 - should read "...established by the late 1880's..."

6) page 6, Section 2.1.1, para. 3, line 4 - should read "...development now consists of a series of three dams (from north to south)..." and the last sentence should read "A forth dam, the Virgin Falls control dam, first constructed in 1926..."

7) page 14, para. 3 - the last sentence should be moved to follow the first sentence

8) page 22, para. 2, sentence 2 - should read "The general principle for..."

9) page 30, para. 1, line 2 - should read "...to be not all that prevalent."

10) page 33, para. 2, sentence 2 - should read "The first redd becomes exposed at about 250 m^3/s."

11) page 62, Photo 3.3.7c - label should read "Damaged, October 1992 (recorded water level 260.23 m to 260.43 m)"

12) page 67, para. 4, starting with sentence 3 - should read "The Nipigon system would be unable to meet the demand for additional electricity and Hydro would have to rely on more costly means of production.

"The value of peaking in hydro-electric generation depends on the marginal costs. The term..."

13) page 70, para. 4 - should read "In 1993, Ontario Hydro adopted a different restriction on the peaking decrease. The initial reduction is 100 m^3/s with a further 50 m^3/s every 2 hours.

14) page 71, Table 4.3.2 and page 72, para. 4 - The estimated value of the replacement cost should have been $450,000 due to the additional off-peak production. This is described in more detail in the *Options Report* (page 57, last paragraph).

15) page 84, Photos 4.5.3 and 4.5.4 - In the first printing of the *Draft Options Report*, the photo labels were interchanged. Subsequent versions were corrected. The correct positions are: top of page, Photo 4.5.4 "...crayfish..."; and bottom of page, Photo 4.5.3 "...sculpins..."

16) page 93, para. 4, line 6 - should read "...that a minimum water flow of 250 m^3/s should be maintained...".

17) page 94, para. 3, line 2 - should read "...river elevation is 183.21 m. The water level at 350 m^3/s is approximately 183.96 m (see Figure 2.1.3)."

18) page 96, para. 3, line 3 - should read "...They see lake levels and river flows as part..."

19) page 114, Table 5.1
- Option B BENEFITS should start with "Compared to A:"
- Option B COSTS should start with "Compared to A:"
- Option C BENEFITS should start with "Compared to B:"
- Option C COSTS should start with "Compared to B:"

A SUMMARY OF THE DRAFT OPTIONS REPORT

GOAL OF STUDY

The goal of this study is to establish, through public involvement, a management option that will reduce the impacts of the operation of Ontario Hydro's Nipigon River hydroelectric dams on the Lake Nipigon/Nipigon River watershed, particularly on the Nipigon River fishery. This management option for the Nipigon River must not further aggravate the impacts of fluctuating water levels on Lake Nipigon. This study commenced in July, 1992 and is to be completed no later than March, 1994.

STEPS IN THE STUDY

In the first year of the study, stakeholders in the Nipigon River, Lake Helen and Lake Nipigon region were interviewed. Some stakeholders living outside the region, but who use the river and lake, also were interviewed. As well, data was collected from available information sources.

In the second year of the project, a preferred water quantity management option for the Nipigon River will be determined by the consultants in consultation with a community-based Nipigon River Water Fluctuations Working Group. A final report detailing the preferred option will be released for community review before it is finalized and submitted to the Nipigon River Management Committee.

THIS REPORT

This report represents the findings of the first year. It outlines the users and conflicts, stakeholders concerns and a preliminary set of management options with supporting data. All those interviewed, as well as other interested parties, are receiving a copy of the report so that they may comment on the findings.

THE FINDINGS

The Users

For the purposes of this study, fish were considered to be the primary user of the Nipigon River watershed.

The other users considered were either: those who are directly affected by the operations of Ontario Hydro's three dams on the Nipigon River; and/or those who use or rely on the fisheries of the Nipigon River and Lake Nipigon watershed.

These include:

- wildlife (for example, bears, eagles, moose);
- First Nations;
- tourist operators, campers and tourists;
- local residents and shore property owners;
- commercial and sport fishermen;
- Ontario Hydro; and
- municipalities.

For more detailed discussion of the users see Chapter 2, Sections 2.2 (Fisheries) and 2.3 (Users).

The Conflicts

When conducting the research for this report, a number of suggestions for achieving the goal of the study were put forward.

It was found, in general, that there are conflicts between:

1) those who want to stabilize the river flows versus those who want to stabilize the fluctuations in the lake levels; and

2) those who want a narrower specified minimum and maximum range of flows and levels versus Ontario Hydro which wants a wider operating range so that water is available when most needed, in the desired quantity.

For a more detailed discussion of these conflicts see Chapter 4.

Preliminary Options

Given the goal of the project, the needs of the different users and the available information, and giving preliminary consideration to resolving the conflicts, the following five management options were identified:

<u>Option A</u>

At all times, the flow rates in Nipigon River below the Alexander Generating Station would be greater than 260 m^3/s from October to May 15 and greater than 170 m^3/s from May 15 to September.

<u>Option B</u>

At all times, the flow rates in Nipigon River below the Alexander Generating Station would be greater than 260 m^3/s from October to May 15 and greater than 170 m^3/s from May 15 to September with a restriction on reducing flow levels to stabilize the fluctuations.

Option C

The average daily flow rate in the Nipigon River below the Alexander Generating Station would be greater than 270 m^3/s in October and greater than 170 m^3/s from November to September with peaking restricted to stabilize the fluctuations.

Option D

Reduce the range of water levels on Lake Nipigon by decreasing the upper operating limit by 0.3 m (1 foot).

Option E

Reduce the range of water levels on Lake Nipigon by increasing the lower operating limit by 0.3 m (1 foot) and decreasing the upper operating limit by 0.15 m (0.5 foot).

Table 5.1, in Chapter 5, expands upon these preliminary options and identifies the benefits and non-monetary "costs" of each option.

NEXT STEPS

Analysis of the Options

Once the public has had an opportunity to comment on the options, each will be evaluated using a Multi-Objective Optimization Model.

The model will provide a way to quantify competing interests so that an optimal operating option, which represents a reasonable compromise to all the stakeholders, can be identified. An important first step is to assign a relative weight or emphasis to each of the benefits and costs.

See Chapter 6 (Evaluation of Options) for further discussion of the model.

The Consultation Program

There are two opportunities to respond to the findings contained in the Draft Options Report and to comment on the proposed options.

Public meetings will be held in Nipigon (Tuesday, June 8), Thunder Bay (Wednesday, June 9) and Beardmore (Thursday, June 10).

The public meetings will start at 7 pm. As well, members of the project team also will be available from 3 to 5 p.m. the same days in the same communities for more informal discussion. Times and locations are provided in the enclosed leaflet. These meetings also will be advertised.

Written comments can either be provided to the study team at the public meetings or mailed to: **Atria Engineering, 8 Stavebank North, Suite 401, Mississauga, L5G 2T4, Attention: Mark Kolberg.**

Consultation Questions

In addition to any comments you may have on the Draft Options Report, answers to the following questions would be most helpful:

1. Are there any other options that should be considered? (Please provide as detailed a description of the option as possible.)

2. Are any of the options which were presented unacceptable? Why?

3. The following are the benefits and costs to be used in the model:

___ fish spawning and habitat
___ loss of traditional lifestyles
___ boating problems
___ cost of electricity
___ other (please specify) ____________
___ shoreline erosion
___ property damage
___ loss of recreational use

Please rank these from 1 (most important consideration) to 8 (least important consideration). Put the same number for those you feel are of equal rank.

The Nipigon River Water Quantity Management Working Group

The results of this consultation will be discussed with a community-based Nipigon River Water Quantity Management Working Group. The working group will assist in determining the weights applied to each of the benefits and costs and will be involved in the modelling exercise.

The first meeting of the working group will be on Thursday, June 24, 1993 in Nipigon. All working group meetings are open to the public.

Terms of Reference for this working group are in Appendix 1A of this report.

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May, 1993

ACKNOWLEDGEMENTS

Nipigon River Management Committee

Ken Cullis, RAP Coordinator
Jake Vander Wal, Ontario Ministry of the Environment/Environment Canada
Dave Nuttall, Public Advisory Committee, Nipigon Bay RAP
Bryan Lomenda, Ontario Hydro
Bill Hutson, Area Supervisor, Nipigon Area, MNR
Rob Swainson, Ministry of Natural Resources, Nipigon District

(Gord Laird, Ministry of Natural Resources, Nipigon District - former member)

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Thanks to all who took the time to provide information and comments.

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1.0 INTRODUCTION

1.1 LOCATION AND SETTING

The Nipigon River watershed is located at the northernmost point of Lake Superior (Figure 1.1.1). Lake Nipigon has a surface area of 4,500 km^2. The Nipigon River flows southward from Lake Nipigon, through Lake Helen and discharges into the northwestern portion of Nipigon Bay on Lake Superior. The river is the largest Lake Superior tributary, with a mean annual flow of 365.3 m^3/s (Kelso, 1977). The Nipigon River drains a tertiary watershed with a surface area of 38,128 km^2, including the Ogoki diversion. Hydro-electric development downstream of Lake Nipigon consists of (from north to south); Pine Portage generating station (GS), Cameron Falls GS and Alexander GS. Seven communities are located in the vicinity of Lake Nipigon and the Nipigon River: Gull Bay First Nation, Beardmore, Macdiarmid, Rocky Bay First Nation, Red Rock First Nation, Nipigon and Red Rock.

Lake Nipigon is considered by many to be the "sixth" Great Lake. It has be noted for its pristine waters, rugged natural beauty and abundant fish and wildlife. Exceptional sport fishing in the Nipigon area has been recognized for well over a century. References to the fish within Lake Nipigon and the Nipigon River date back to the early fur traders and the establishment of trading posts in the early 1700's. A wonderful historical perspective of the fisheries in this area is presented by Wilson (1991).

Sport fishing had become established by the late 1980's, with brook trout considered the most sought after species. Afternoon catches of brook trout totalling 64 pounds (average fish weight of 4.3 pounds) were reported with trout in the two pound range being very abundant (in MacCallum, 1989). The Canadian Pacific Railway began to promote travel to the area as a tourist destination before the turn of the century.

The Nipigon River is probably best noted among anglers for producing trophy sized brook trout. The world's largest brook trout (14 lbs, 8 oz. or 6.6 kg) was caught there in 1915 (Scott and Crossman, 1973). Since then, the river has continued to produce trophy sized brook trout, most recently within the Molson's "Big Fish" contest. The combination of road accessibility, majestic scenery and world class fishing continues to attract fishermen from around the world to the area.

1.2 BACKGROUND

The Nipigon River Management Committee was formed in January, 1990 in response to increasing recreational, industrial and commercial demands being placed on the Nipigon River watershed and conflicts which had arisen among water resource users. This inter-agency Management Committee includes representatives from the Ontario Ministries of Natural Resources and the Environment, Ontario Hydro, the Nipigon Bay Remedial Action Plan (RAP) Team and the Nipigon Bay RAP Public Advisory Committee. In 1991, the Nipigon Bay RAP identified potential impairments of beneficial uses in the lower Nipigon River, including Lake Helen. These include:

Figure 1.1.1 **Study Area**

-The historically world renowned brook trout population has been confined to stretches of the river by hydro dams and is severely reduced within those stretches due to a variety of causes.

-Water level fluctuations impact aquatic organisms and the habitat of the brook trout and other fall spawners.

-Historical commercial fisheries on Lake Helen have been eliminated (i.e., lake sturgeon) or reduced (i.e., lake whitefish). Subsistence fishery still occurs but at reduced levels.

-Algae growth on walleye spawning beds in the lower Nipigon River may have affected walleye rehabilitation.

-Accumulations of bark and wood fibre, resulting from log drives, may effect aquatic organisms. In addition to causing changes in fish habitat, scouring by log drives and accumulations of woody material have reduced the diversity of benthos.

-Increased siltation due to erosion of river banks and landslides.

-Introduction of exotic salmonids and lamprey.

This two-year study has been initiated in response to growing public concern regarding the effects of water level fluctuations on the Lake Nipigon/Nipigon River ecosystem and is in support of the Nipigon Bay Remedial Action Plan's Use Goal #10;

> "Water levels in key river spawning areas should be maintained to allow natural reproduction of fish and other aquatic organisms. The aquatic community of Nipigon Bay and its watershed should be protected from negative impacts associated with artificially controlled river flow fluctuations. Specifically, the impacts of exposing spawning areas and covering the river bottom with solids, originating from artificially induced river bank erosion, should be minimized."

The study is being conducted by a consulting team, headed by Atria Engineering Hydraulics Inc. of Mississauga, under the supervision of the Nipigon River Management Committee. Atria is being assisted in this study by Ecological Services for Planning Limited, David Evans, community affairs consultant, MWR and Associates, Alan A. Smith, Inc., E. Soulis and K. Ponnambalam.

1.3 SCOPE OF STUDY

Goal

The overall goal of the project is to establish - with as high a degree of community consultation and consensus as possible - a preferred option for water quantity management in the study area. To achieve this, the project requires the collection, interpretation and analysis of data and an appropriate consultation process that involves stakeholders and the general public.

Approach

The study will identify and cost water quantity management options that minimize the effects of fluctuating water levels on water uses, and the natural environment in the study area. It will focus on interpretation and analysis of technical data and public consultation. The emphasis for the first year will be on the identification of stakeholder issues and conflicts, and the development of water quantity management options.

During the second year, the public will be asked to review the draft options. Then costed options will be presented to the public and a consensus sought on a preferred option and implementation process.

Study Limits

The study area for this project covers the high water mark on Lake Nipigon, as well as Nipigon Bay, but only with regards to the effect water fluctuations have on the aquatic community in the Bay. In the original Terms of Reference, the tributaries to Lake Nipigon were not included in the study and the Little Jackfish River was to be treated as a constant water source with minor fluctuations only. However, after consultation with the stakeholders, especially on Lake Nipigon, the study team has recommended that greater consideration be given to the Ogoki diversion.

Process

Year 1 tasks can be grouped into two categories:

1. Data Collection

   During this phase, the consultants met with watershed users to identify, confirm and learn more about their concerns with respect to present and future water quantity management. As well, a review of existing literature was undertaken on the cumulative effects of other pressures (e.g. competition with other fish, lampricides, pollution, commercial fishing, angling and log drives) on the Nipigon River fisheries. Specifically, field studies were carried out to examine the effects of lampricides and dewatering on the fish habitat.

2. Report Preparation

This report outlines the uses and conflicts, stakeholder concerns and a preliminary set of management options.

The study is utilizing a multi-objective optimization model for management of the Nipigon River water flows and levels. This model incorporates social and environmental objectives into the management procedures. Using the model will assist the team in identifying conflicts and options and in the interpretation and analysis of the data.

Year 2 tasks can be grouped into four categories:

1. Plan Steering Committee and Public Review of the Draft Options Report

After it has been reviewed by the Plan Steering Committee, the draft options document will be released for public review. This review will include a comment period and combined open houses/public meetings. Additional "Update" newsletters and advertising will keep the stakeholders informed.

2. Revision of the Report to include Costed Options

New information and comments provided during the public review of the draft options report will be incorporated into the report and the proposed options will be costed. As well, an assessment of the public reaction to the options and the potential for consensus will be provided to the Plan Steering Committee.

3. Public Consultation on the Costed Options Report

During this phase, the costed options first will be presented for general public discussion at combined open houses/public meetings and then the subject of discussion by the community. It is the goal of this phase to come to a community consensus on a preferred management option and implementation process.

The optimization model will be used to show the impact of optimal or sub-optimal policies on conflicting user-interests.

4. The Preparation of a Preferred Option Plan

Once a consensus on the preferred option has been reached, a final report which includes an implementation process, will be produced, reviewed by the Plan Steering Committee and then presented to the public.

2.0 DESCRIPTION OF THE NIPIGON WATERSHED

2.1 LAKE LEVELS, RIVER FLOWS AND HYDRO DEVELOPMENT

2.1.1 Introduction

The Nipigon River Basin, as seen in Figure 1.1.1, comprises the Nipigon River, including Lake Helen and Polly Lake, Lake Nipigon and a portion of the Ogoki River basin.

The Nipigon River flows southward from Lake Nipigon, through Lake Helen and discharges into the northwestern portion of Nipigon Bay on Lake Superior. The river is the largest Lake Superior tributary, with a mean annual flow of 365.3 m^3/s (Kelso, 1977) and it drains a tertiary watershed with a surface area of 38,128 km^2, including the Ogoki diversion (Shraeder, 1983). Under natural conditions, the Ogoki watershed drains towards James Bay. Since 1943, the Ogoki control dams have diverted water from the Ogoki to the Nipigon watershed thus increasing the mean annual flow.

Hydro-electric development on the Nipigon River, downstream of Lake Nipigon, has greatly altered the physical and environmental character of the river by eliminating much of the white water rapids and by forming reservoirs. Shorelines along the river and on Lake Nipigon were flooded by the increase in the water levels. The hydro-electric development consists of a series of four dams (from north to south); Pine Portage Generating Station (GS) (constructed 1950), Cameron Falls GS (constructed 1920) and Alexander GS (constructed 1930). The operation of the dams has changed the natural flow patterns on the river and levels on Lake Nipigon. The Virgin Falls control dam, first constructed in 1926, was flooded as a result of the subsequent development of the Pine Portage GS and has been partially dismantled.

The levels of Lake Nipigon and the flows in the Nipigon River are the combined result of the following factors: the physical characteristics of the surrounding drainage basin (i.e., area and terrain), the size of the lake and the flow capacity of the river; the amount of natural inflow due to runoff from precipitation and groundwater; the Ogoki diversion inflow; evaporation; and the effects of the hydroelectric development.

The recorded discharges of the Ogoki diversion and the Nipigon River, along with the recorded levels of Lake Nipigon are presented in graphical form in Appendix 2A. Figure 2.1.1 is an example of the discharges and levels in Appendix 2A for the period from 1981 to 1990. The monthly maximum, average and minimum daily discharges (in m^3/s) for the Ogoki diversion (top of page) and the Nipigon River (bottom of page) are given along with the maximum, average and minimum daily levels (in metres above sea level) for Lake Nipigon (middle of page). In Figure 2.1.1, for each month, the top of the unshaded bar on each plot represents the maximum recorded daily average discharge or level. The bottom of the coloured bar represents the minimum recorded daily average discharge or level for that particular month. The intersection of the unshaded and coloured parts of the bar is the average daily discharge or level for the month in question.

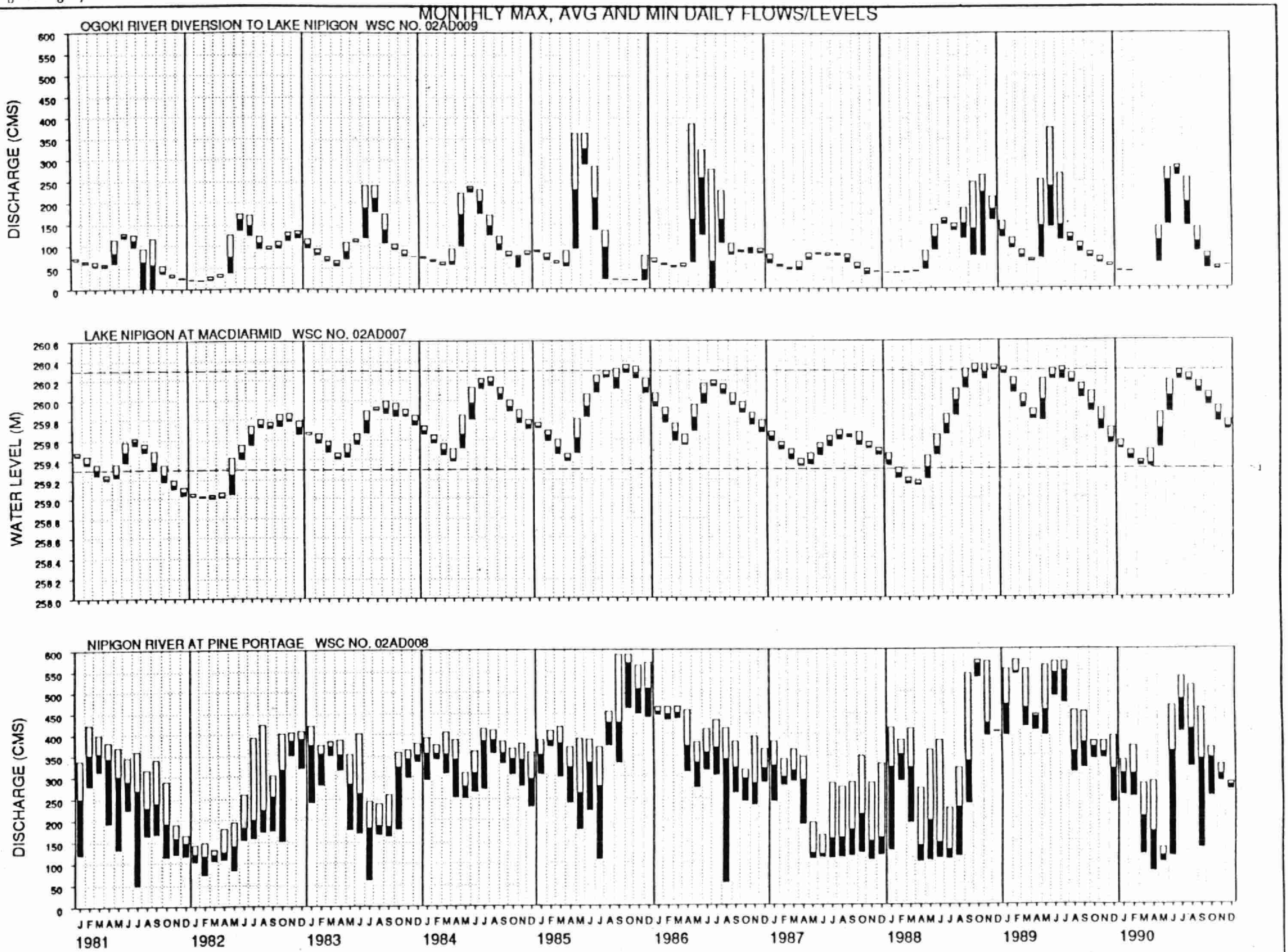


Figure 2.1.1

Nipigon River, Lake Nipigon and Ogoki Diversion - Monthly maximum, average and minimum daily flows/ levels

2.1.2 Nipigon River

The Nipigon River drops a total of 76 m from Lake Nipigon to Nipigon Bay over a distance of about 48 km. The potential for hydro-electric generation on the Nipigon River did not pass by unnoticed:

> "the water-powers of the Nipigon River will be of more than local importance, when utilized, as they are probably one of the largest and best of the more readily accessible undeveloped water-powers in Canada" (Wilson, 1910, cited in Wilson, 1991).

The development of hydro-electric generation on the Nipigon River is an important aspect of the development of industry in the Thunder Bay area. A description of the origin and identification of the requirements of the Cameron Falls GS is presented in Appendix 2A.1

The Hydro Electric Power Commission (HEPC) developed water power on the Nipigon River at Cameron Chutes and Camp Alexander under Water Power Leases No.'s 33 and 44 (ref. OMNR Licence of Occupation No. 2585).

Much of the following information on the historical development of the hydro facilities is from Wilson (1991). In 1918, construction on the Cameron Falls dam and generating station was started by the HEPC. It became operational with two units in 1920. Two additional units were added in 1924 and by 1926 two more units were in place. In 1958, the seventh unit was installed bringing the efficient output of the plant, at normal head, up to 64,700 kW (maximum 77,480 kW).

Jessie Lake is the reservoir that was created when Cameron Falls GS was constructed.

By 1924, surveying of the site of the proposed control dam at Virgin Falls, at the outlet of Lake Nipigon was being undertaken. The Virgin Falls control dam was to provide an adequate supply of water at all times to the Cameron Falls station by controlling the outflow and regulating the level of Lake Nipigon. By 1926, the Virgin Falls dam was built. It raised the level of Lake Nipigon by 0.4 m (1.33') (Near, 1982, cited in Wilson, 1991). In conjunction with Virgin Falls Dam, a block dam was constructed at Black Sturgeon Bay.

The Alexander GS dam was placed into service in 1930 with two generating units. It was expanded to three units in 1931 and to four units in 1945. The total plant efficient output, at normal head, is 62,200 kW (maximum 66,470 kW). A fifth unit was added in 1958.

Construction of the Pine Portage GS dam, to raise Lake Nipigon to the higher 260.6 m (855.0') level, did not occur until 1948 to 1950. In Water Power Lease No. 36, MNR gives Ontario Hydro, "for the full and end term of 99 years" (from January 12, 1945) the right to develop a power plant at Pine Portage and regulate the level of Lake Nipigon, including flooding the area between Pine Portage and Virgin Falls. The lease was signed in August, 1953, As a result of the construction of Pine Portage GS, the control dam at Virgin Falls was flooded and was partially dismantled. In 1954, two additional turbines were added to Pine Portage to bring the total to four. The total plant efficient output, at normal head, is 108,700 kW (maximum 130,500 kW).

Ontario Hydro regulates the discharge at Pine Portage GS, Cameron Falls GS and Alexander GS for hydro-electric power generation. When there is sufficient water, river discharges are usually about 350 m^3/s at the peak efficiency of the hydro-electric system. In the past, the system could normally operate between 530 m^3/s to 113 m^3/s, the minimum mean daily discharge in the winter, and 70 m^3/s, the minimum instantaneous discharge in winter (Pope and Metcalfe, 1991, draft). The maximum flow is 566 m^3/s although at times this is exceeded.

Under a present interim flow agreement between Nipigon MNR and Ontario Hydro, originally established in 1990, the minimum daily instantaneous discharge is restricted to greater than 260 m^3/s from October 1 through to May 15 and 170 m^3/s for the remainder of the year (ref. Ontario Hydro Information Release, October 15, 1990; letter January 8, 1991, Q. Day, Nipigon MNR to B. Lomenda, Ontario Hydro; B. Lomenda, Ontario Hydro, 1993, pers. comm.; R. Swainson, Nipigon MNR, 1993, pers. comm.).

The mean, standard deviation, maximum and minimum values of daily flows from Pine Portage GS, from 1951 to 1990, are presented in Table 2.1.1a. A further breakdown of the Pine Portage flow statistics, by decade (i.e., 1951-60, 1961-70, 1971-80, 1981-90) is provided in Appendix 2B. Appendix 2B also provides the percentage of time, by month and decade, that the daily average flows at Pine Portage GS were less than 270 m^3/s and less than 260 m^3/s.

It should be noted that the flows at Cameron Falls GS and Alexander GS are generally very similar due to the limited storage capacity between the two stations. The flows at these two stations and at Pine Portage GS are also generally the same but they can, and do, vary at times due to the larger storage capacity of Jessie Lake.

Alexander GS is the final point of regulation for the lower Nipigon River. The station turbines operate over a range of 70 to 496 m^3/s with peak efficiency occurring at about 398 m^3/s (about 31 m^3/s greater than the mean annual flow of 367 m^3/s). Although the hourly flow can go as low as 70 m^3/s during normal operation, the instantaneous discharge from Alexander GS rarely drops below the mean daily flow (winter) of 113 m^3/s. When operating in a peaking mode, the discharge from Alexander GS could range from 113 m^3/s to 350 m^3/s in a 24 hour period (Pope and Metcalfe, 1991, draft).

Table 2.1.1.a Nipigon River at Pine Portage (WSC NO. 02AD008)

YEARS: 1951-1990	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	1240	1130	1240	1200	1240	1200	1240	1240	1200	1240	1200	1240	14610
MEAN (M3/S)	362.	377.	373.	349.	315.	359.	362.	351.	336.	354.	348.	345.	352.
ST. DEV. (M3/S)	94.	96.	104.	110.	115.	124.	133.	105.	95.	94.	99.	102.	107.
MAXIMUM (M3/S)	575.	595.	583.	580.	609.	606.	629.	640.	597.	629.	631.	640.	640.
MINIMUM (M3/S)	1.	72.	104.	75.	60.	98.	33.	35.	44.	68.	104.	75.	1.

Table 2.1.1b Daily Water Level at Macdiarmid, Lake Nipigon (WSC NO. 02AD007)

YEARS: 1951-1992	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	1279	1140	1262	1238	1295	1227	1292	1280	1246	1282	1232	1246	15019
MEAN (M)	259.76	259.65	259.54	259.46	259.63	259.92	260.07	260.07	260.03	259.98	259.91	259.82	259.82
ST. DEV. (M)	0.321	0.301	0.269	0.227	0.250	0.288	0.270	0.251	0.261	0.292	0.316	0.328	0.282
MAXIMUM (M)	260.33	260.22	260.05	259.90	260.37	260.56	260.56	260.45	260.51	260.51	260.54	260.43	260.56
MINIMUM (M)	258.70	258.64	258.61	258.61	258.84	259.09	259.38	259.47	259.29	259.17	258.94	258.79	258.61
MAX RANGE (M)	0.17	0.23	0.23	0.22	0.68	0.48	0.24	0.28	0.27	0.24	0.26	0.20	0.68

WSC - Water Survey of Canada

1990 Flow Tests

In 1990, Ontario Hydro undertook flow tests at the Alexander GS to better describe the relationship between discharge, river elevation, other hydraulic parameters and brook trout spawning habitat at eight river transect locations below Alexander GS (Pope and Metcalfe, 1991, draft). Discharge was regulated to achieve test flows of 540, 350, 260, 170, 113 and 70 m^3/s. The transect locations were as follows (see Figure 2.1.2):

SB1	-	tailwater below Alexander GS
SB1A	-	Alexander Backpool (embayment below dyke east of Alexander GS)
SB2	-	at the TransCanada natural gas pipeline
SB3	-	location used by Ontario Hydro and the Federal Government as a streamflow metering section.
SB4 to SB7	-	in the vicinity of Parmacheene Bridge (SB6 just upstream of bridge)
SB8	-	Gapen's Pool (outlet of Lake Helen), 15 km downstream of Alexander GS.

The channel geometry of these transects was surveyed (including a portion of the river bank beyond the high water mark) and are shown in Appendix 2B.1. The river cross-sections for the transects at Parmacheene (SB6), Alexander Backpool (SB1a) and Gapen's Pool (SB8) are shown in Figure 2.1.3.

The river widths between Alexander GS and Lake Helen range from 85 to 190 m and the depth is up to 15 m. During the flow tests, water elevations were recorded every 15 minutes at SB1, SB2, SB3, SB4, SB7, SB8 and at Steamboat Bay on Lake Helen. Spot elevations only were taken at SB1A, SB5, SB6 and at the Town of Nipigon government dock.

Transects SB1 and SB6 have a "U" shaped channel with a shallow cobble bar on one side (see Appendix 2B.1). The channel width is about 166 to 188 m and the depth is less than 3 m when the discharge is 350 m^3/s. The bars are exposed when the discharge is below 270 m^3/s. As discharge decreased from 350 to 113 m^3/s, the wetted perimeter at these sites decreased about 27 to 23% and the channel velocities dropped from 0.60 - 0.62 m/s to 0.31 - 0.35 m/s (Pope and Metcalfe, 1991, draft).

Transects SB2, SB3 and SB4 have "U" shaped channels with widths of about 120 m and depths of 10 to 15 m when the flow rate is 350 m^3/s (see Appendix 2B.1). As discharge decreases from 350 to 113 m^3/s, the wetted perimeter at these sites decreased about 5 to 14%. As discharge decreases from 540 to 113 m^3/s, the channel velocity dropped from 0.88 m/s to 0.15 m/s (83% decrease) (Pope and Metcalfe, 1991, draft).

Transects SB5 and SB7 were sited at points where the river has a "V" shape channel with a width of about 85 m and depth of 6 to 7 m when the flow rate is 350 m^3/s (see Appendix 2B.1). These sites exhibit hydraulic control in the upper river. As discharge decreases from 350 to 113 m^3/s, the wetted perimeter at these sites decreases about 12%. However, as discharge decreases from 540 to 113 m^3/s, the channel velocity dropped from 1.39 m/s to 0.47 m/s (66% decrease) (Pope and Metcalfe, 1991, draft).

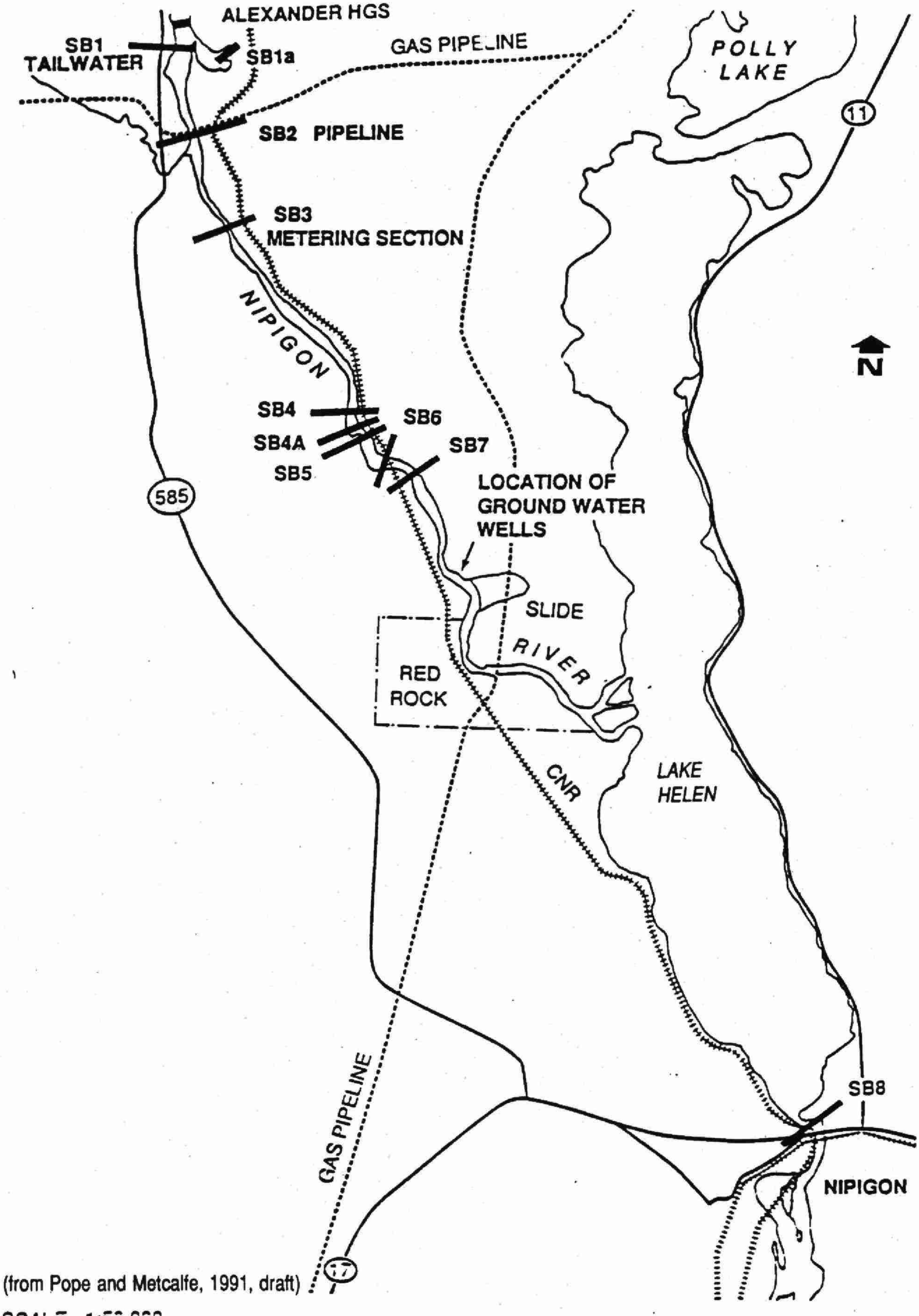
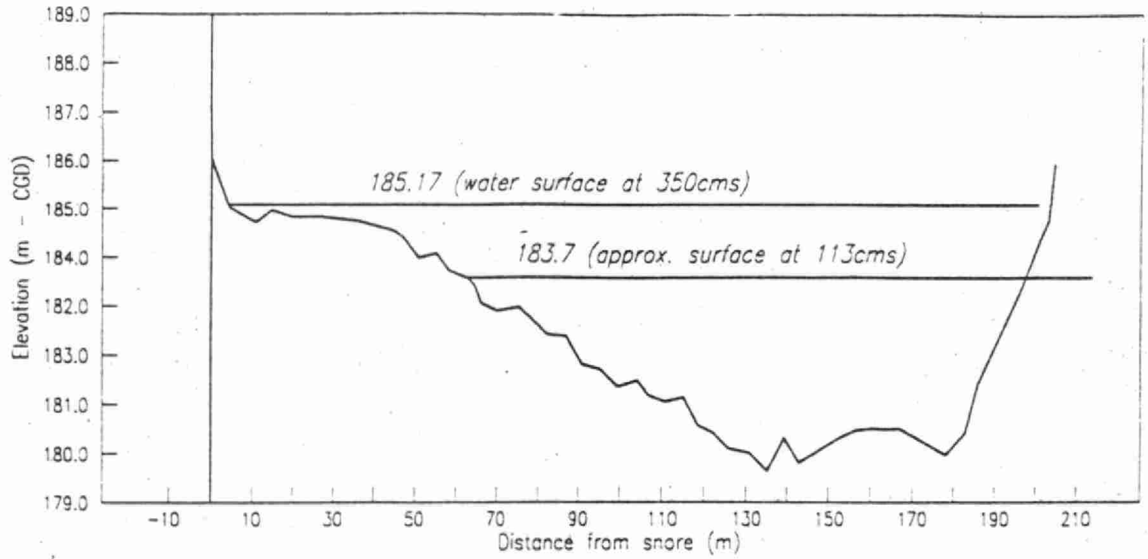
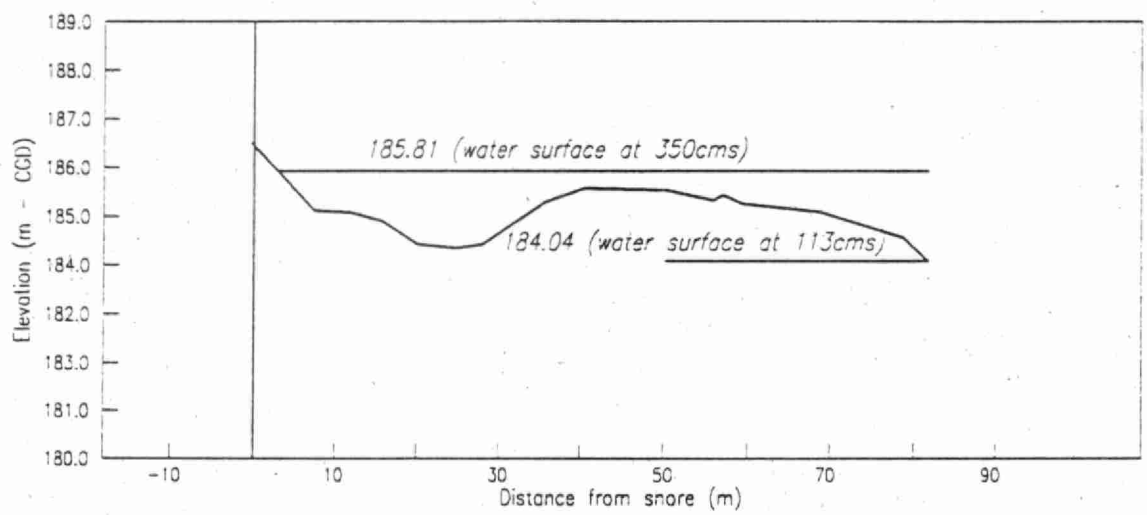


Figure 2.1.2 Location map of Nipigon River transects

River Cross Section: at Parmacheene



River Cross Section: Alexander Backpool



River Cross Section: Gapen's Pool

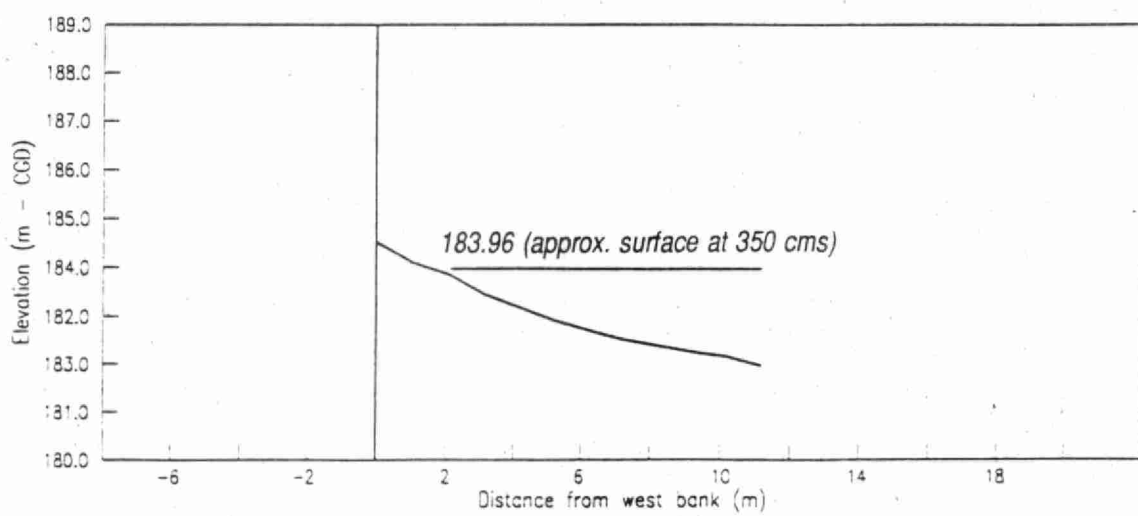


Figure 2.1.3 Nipigon River cross-sections at brook trout spawning sites

Figure 2.1.4 shows the flow regime over the eight day test in 1990. The flows shown are the recorded flows at Alexander GS and require some explanation (Pope and Metcalfe, 1991, draft). First, the 540 m^3/s flow is plotted at about 510 m^3/s. The river is regulated using Cameron Falls GS calculated flows. A well known discrepancy between the rating curves for the two stations at high flows results in Alexander GS showing a slightly lower flow rate than the Cameron Falls GS flow rate (i.e., 510 versus the actual 540). The second point is on October 1-2, the 350 m^3/s flow displays a fluctuating flow. This was caused by faulty data transmission from one generating unit at the time of the test. Later analysis confirmed the 350 m^3/s flow.

Figure 2.1.5 shows the water level elevations at transect locations at the tailwater, SB4, SB7 (near Parmacheene Bridge) and SB8 (Gapen's Pool), Steamboat Bay (north end of Lake Helen) and the Nipigon dock at the various times of the flow test. It should be noted that in Pope and Metcalfe (1991, draft) there appears to be some discrepancies between their references to the "tailrace", the "tailwater" and transect "SB1". The study team will attempt to clarify this information during the second year of the study.

The river elevations reported by Pope and Metcalfe (1991, draft) at the transects, under various flow conditions, are shown in Table 2.1.2. Again, it should be noted that in Pope and Metcalfe (1991, draft) there appears to be some discrepancies between their references to the "tailrace", the "tailwater" and transect "SB1". Also, there appears to be some discrepancies between the levels in Table 2.1.2 and the levels shown on the figures in Appendix 2B.1. From this information, they developed rating curves of river discharge and elevation for transects SB1, SB4, SB7 and SB8, as shown in Figure 2.1.6.

Another objective of the flow test was to determine how quickly water levels would fall and rise in the river during a peaking event. During the test, the discharge was dropped from about 350 m^3/s (at 18:45 on October 1) to 113 m^3/s and then restored to 350 m^3/s to simulate a peaking decay of 13 hours in duration. Within the first 6 km of the river, water levels at SB1 and SB4 responded rapidly and declined 1.51 and 1.17 m respectively in this 13 hours (see Figure 2.1.7). At SB1, 50 percent of the decline occurred in about one hour and 90 percent in 4 hours. At SB4, it took about 1.25 hours for 50 percent of the decline to occur and about 6 hours for 90 percent. The backwater effect of Lake Helen on SB4 was observed in this test (i.e., the decline in the elevation at SB4 was not as great as at SB1).

Changes in the water elevation in Lake Helen and at Gapen's Pool (SB8) were considerably muted. At Gapen's Pool, the decline did not appear until 2.5 hours after the event at Alexander GS. The elevation at Gapen's Pool declined about 0.25 m over the 13 hour decay period. The final elevation at Gapen's Pool, after a peaking decay, is controlled by the initial elevation of Lake Helen. It has been observed that it takes at least 2 days to approach equilibrium elevation after a change at Alexander GS (Pope and Metcalfe, 1991, draft).

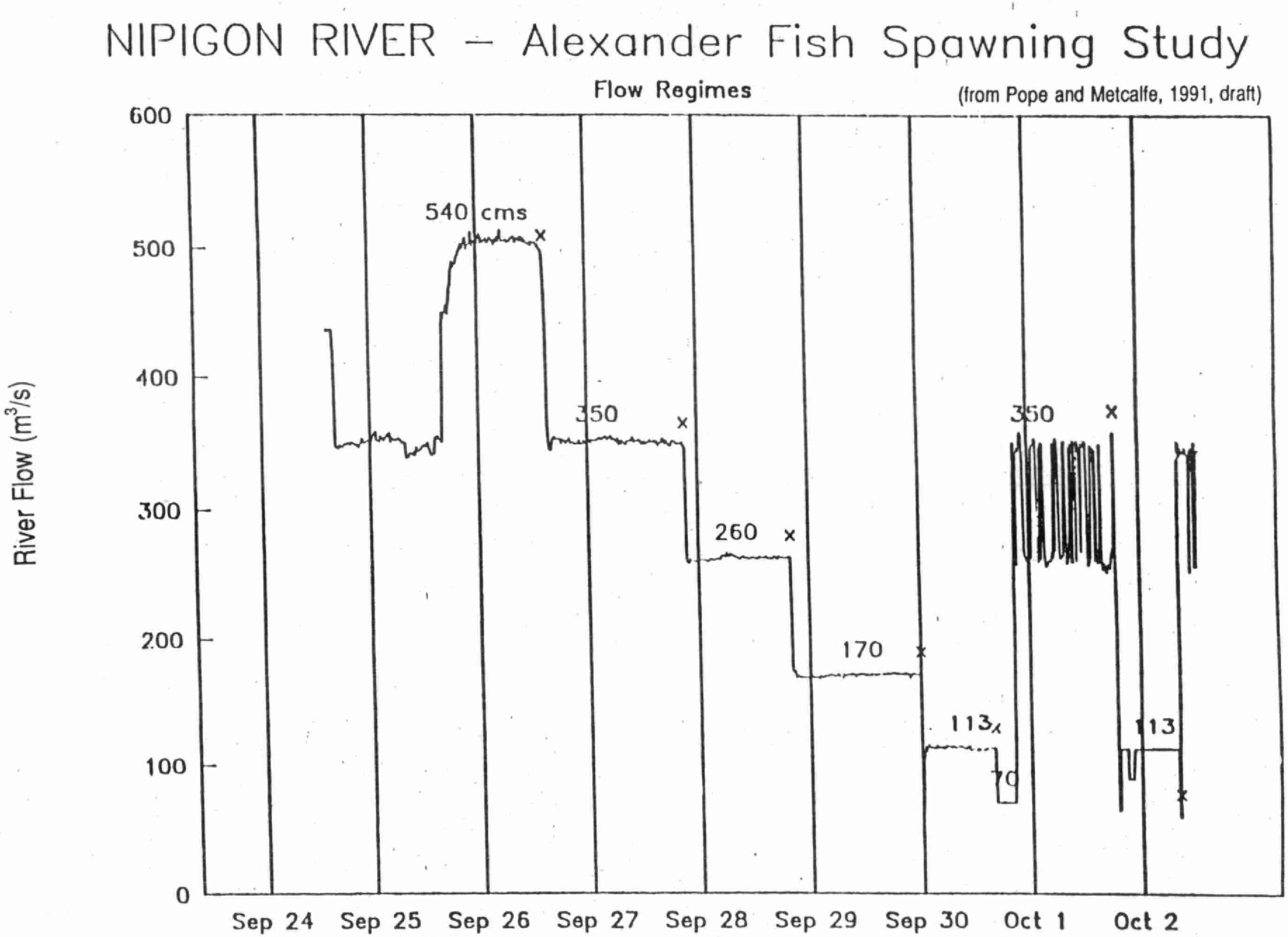


Figure 2.1.4 Nipigon River flows during 1990 flow study

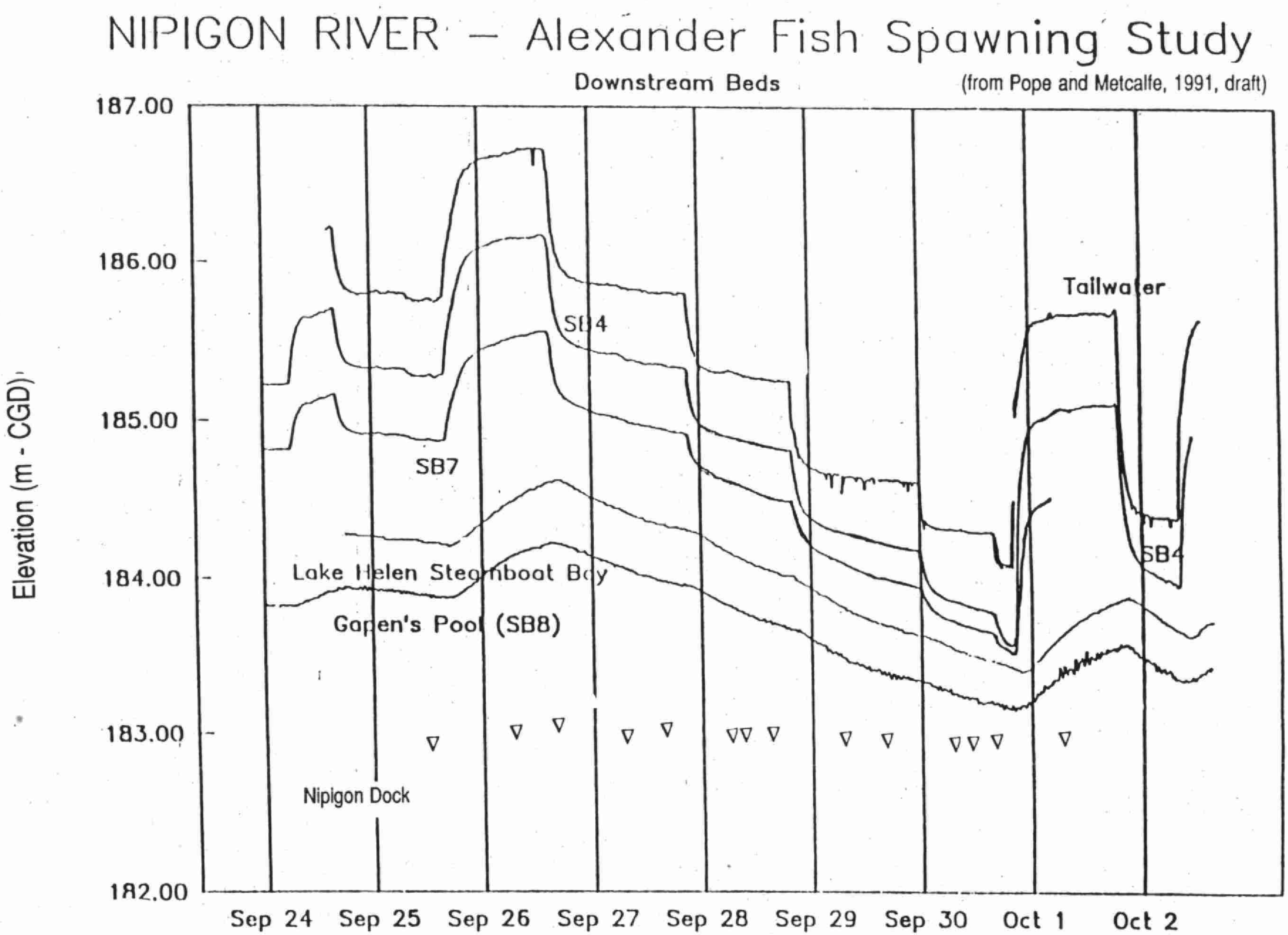


Figure 2.1.5 Nipigon River elevations during 1990 flow study

Table 2.1.2 Elevation of Nipigon River at selected sites

Discharge (m^3/s)	Elevations (m) of water level at sites (transects) Tailwater	SB1	SB2	SB3	SB4	SB7	Steamboat Bay	SB8
540	186.64	186.61	186.58	186.48	186.12	185.53	184.61	184.23
350	185.80	185.74	185.67	185.61	185.33	184.92	184.30	183.96
260	185.25	185.15	185.06	185.03	184.82	184.49	184.02	183.68
170	184.61	184.50	184.36	184.34	184.19	183.96	183.64	183.36
113	184.30	183.95	183.86	183.86	183.79	183.66	183.47	183.21
70	184.08	183.73	183.62	183.61	183.59	183.53	183.43	183.18

See text of report, Chapter 2, Section 2.1.2

(after Pope and Metcalfe, 1991, draft)

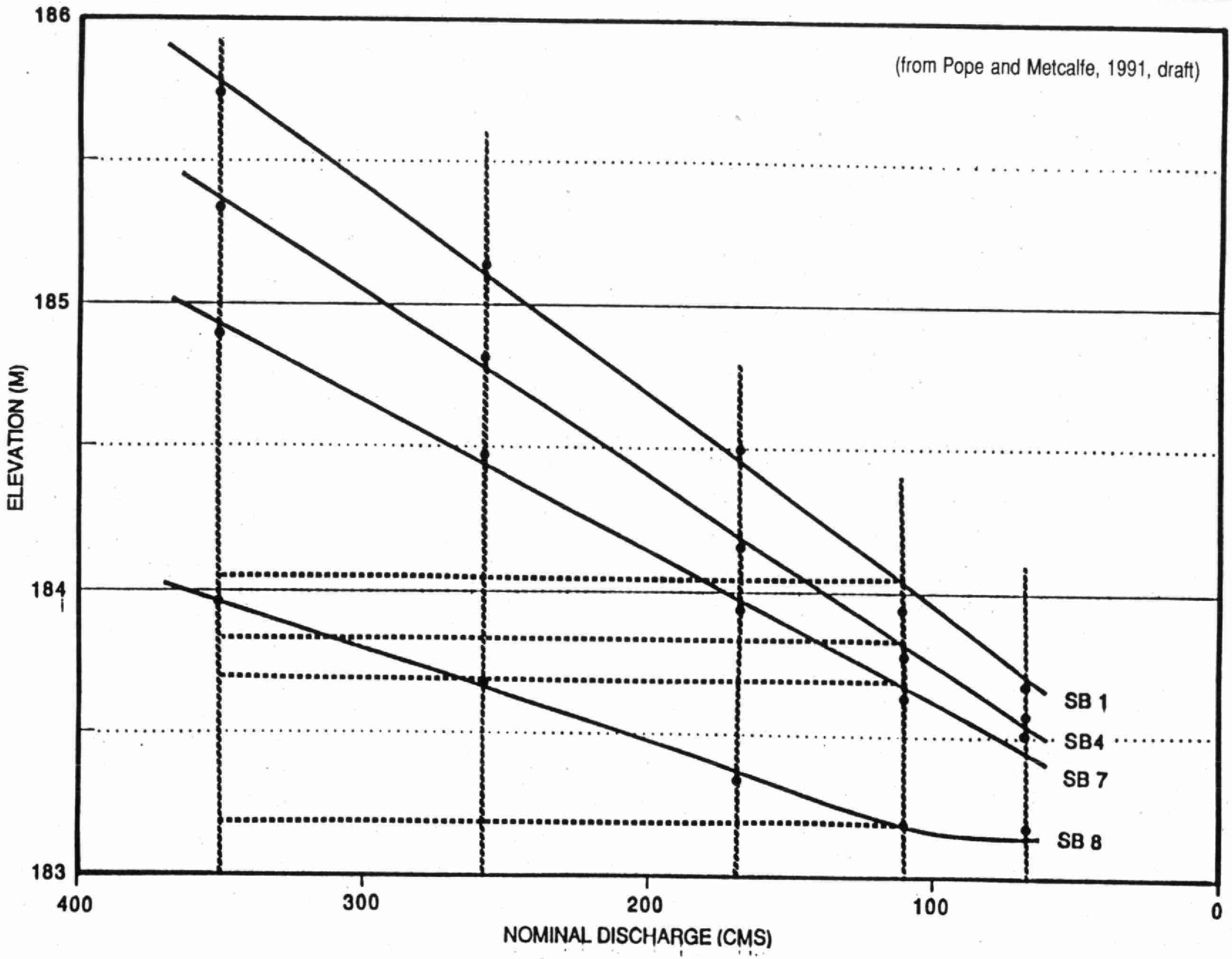


Figure 2.1.6 Nipigon River rating curves between >70 and 350 m³/s

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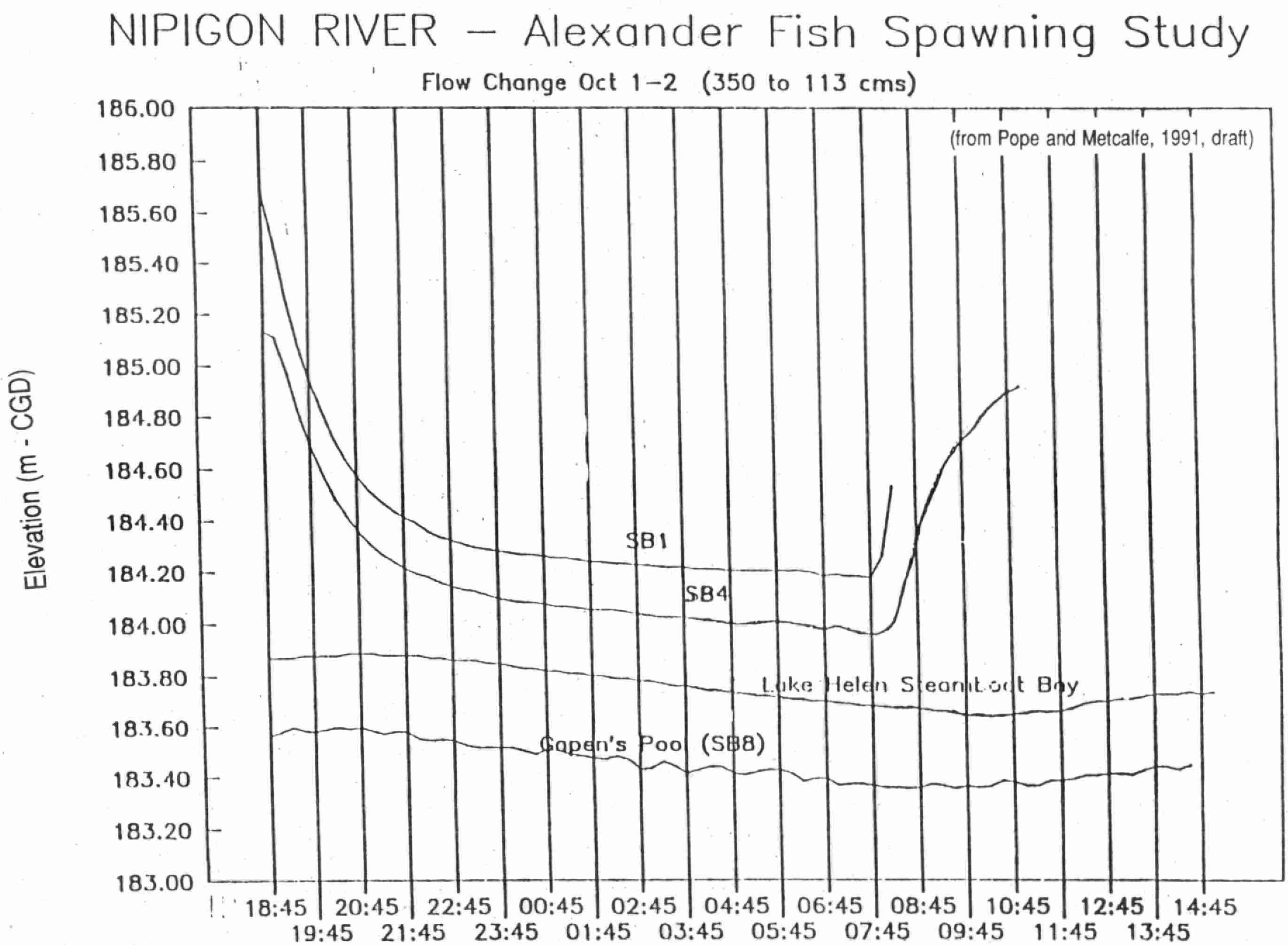


Figure 2.1.7 Nipigon River drawdown (350 to 113 m³/s), Oct. 1-2, 1990 flow study

2.1.3 Lake Helen and Polly Lake

The Nipigon River flows southward into Lake Helen. Polly Lake is connected with Lake Helen in the north (see Figure 1.1.1). Lake Helen behaves like a buffer. It temporarily stores the incoming water and releases it at the outlet, Gapen's Pool. From there the water drains into Nipigon Bay on Lake Superior. The water elevation at Lake Helen is influenced by the Nipigon River discharge and the water level of Lake Superior. This is demonstrated by the rating curves presented in Appendix 2B.2. The rating curves were prepared by Ontario Hydro (ref. Drawing 143-A-317) and show the relationship of the water elevation at Lake Helen, the discharge from Lake Helen and the Lake Superior elevation.

Lake Helen water level data (at Steamboat Bay) for part of 1977, part of 1978, part of 1979 and 1980 to 1987 are presented in Appendix 2B.3. Water level data is not available for Polly Lake.

Response of Lake Helen to the river discharge is reasonably quick. Figure 2.1.7 shows the gradual decline of the Lake Helen water level shortly after the flow at Alexander GS was reduced from 350 m^3/s to 113 m^3/s.

In the second year of the study, a simple routing model will be developed to establish a relationship between the flow into Lake Helen and the water level of Lake Helen. This model will make use of the Lake Helen discharge rating curves, the measured levels of Lake Superior, the measured levels of Lake Helen (Appendix 2B.3), the recorded flows from Alexander GS and the data measured at Lake Helen (Steamboat Bay and Gapen's Pool) during the Ontario Hydro 1990 flow test. Daily mean water levels of Lake Superior at Thunder Bay, from 1951 to 1991, have already been obtained from Marine Environmental Data Service (MEDS).

2.1.4 Lake Nipigon

Lake Nipigon has a surface area of about 450,000 hectares with a length of about 110 km in the north-south direction and about 70 km in the east-west direction. The local drainage area into the lake is approximately 24,500 km^2.

The level of Lake Nipigon is governed by the inflow, including the inflow from the Ogoki diversion, natural inflow from groundwater and runoff due to precipitation, losses due to evaporation and the outflow to the Nipigon River and the regulation of the dams. To lower the level of the lake 1 cm, assuming all other flows into the lake were zero (including all the natural creeks and rivers, the groundwater, and the Ogoki diversion), would take 22 hours at the maximum river discharge of 566 m^3/s and 35.7 hours at an average discharge of 350 m^3/s. Under more realistic conditions (i.e., continued inflow from other sources) variation of the average level of the lake, on a monthly basis, is typically in the order of 10 to 20 cm except during freshet.

Storm surge, also known as wind set-up, is the temporary increase in water level, above the average, at one end of a lake during a strong wind. The wind blowing over the surface of the water "pushes" the water level up at the downwind end of the lake and there is a corresponding decrease in the

water level at the upwind end of the lake. Reported storm surge values, from stakeholders in the area, typically ranged from 15 cm to 30 cm but went as high as 60 cm. Ritchie and Black (1988) reported differences (in the minimum monthly levels) between the Macdiarmid and Wabinosh gauges of 5 to 15 cm. In a study completed for Ontario Hydro, MM Dillon (1991) reported the following:

> "Variation of Lake Nipigon water levels are typically on the order of 20 cm during the more extreme set-up events, with a response time to the wind forcing of approximately 2 to 4 hours".

From 1921 to 1925, before construction of the Virgin Falls dam in 1926, the water level at Lake Nipigon observed at Orient Bay (see Appendix 2A) ranged from 258.4 m to 259.5 m (847.8' to 851.4'). As noted earlier, in Section 2.1.2, by 1926, the Virgin Falls dam was built, raising the level of Lake Nipigon by 0.4 m (1.33') (Near, 1982, cited in Wilson, 1991).

In 1927, surveys were being carried out to determine the maximum water levels that could be obtained on Lake Nipigon without extensive damages. At that time a level of 260.6 m (855.0') was proposed (HEPC, 1927, cited in Wilson, 1991).

Approval was granted, by Order-in-Council, dated April 25, 1930, to raise the level of Lake Nipigon and operate between elevations 257.86 m and 260.60 m (846.0' and 855.0') (OMNR, 1989). However, License of Occupation No. 2585, issued in 1932, granted approval to flood only to elevation 260.0 m (853.0'). It further stated "that if the water at any time is required to be held higher than this level, that the shores of Lake Nipigon must be cleared of all trees and debris to the satisfaction of the Minister, below any higher level which may be permitted" and that the HEPC "is held responsible for any damage to private or public interests, as may be determined and fixed by the said Minister".

As outlined in Section 2.1.2, Water Power Lease No. 36 authorized a power plant at Pine Portage, regulation of the level of Lake Nipigon and flooding the area between Pine Portage and Virgin Falls. The completion of Pine Portage GS in 1950 enabled Ontario Hydro to raise Lake Nipigon to the higher 260.6 m (855.0') level stated in 1930 Order-in-Council. A discussion of the clearing that was specified in License of Occupation No. 2585 is provided in Chapter 4, Section 4.12.2.

In July, 1974, the Ontario Minister of Natural Resources issued License of Occupation No. 7785 to Ontario Hydro for occupying and maintaining the dam sites at Virgin Falls and Black Sturgeon Bay in order to regulate the level of Lake Nipigon. The wording of the License of Occupation stated that the waters of Lake Nipigon "shall not be impounded at any time to an elevation exceeding 855 feet [260.6 m] Geodetic Survey of Canada Datum" and that Ontario Hydro shall not have the power "to overflow or cause to be overflowed any land or lands other than those described herein". License of Occupation No. 7785 "is coterminous with the extension of Water Power Lease No. 33 to December 31, 1982". It further states that the Licence "may be revoked or cancelled at any time by the Minister of Natural Resources when it shall by him be deemed in the public interest so to do".

It is the study team's understanding that Ontario Hydro interprets the water level requirements to be based on the average daily water level of Lake Nipigon. The water levels are further discussed in Section 4.6.

Lake Nipigon is operated as an annual reservoir system by Ontario Hydro (R. Penn, Ontario Hydro, pers. comm., 1993), i.e. under normal or average conditions (precipitation and runoff), the reservoir (Lake Nipigon) takes slightly more than one year to fill up and slightly more than one year to empty. The general principal for operating the power generating stations includes:

- storing as much as possible of the spring freshet;
- holding water back through the summer for winter drawdown (for power generation); and
- dropping the lake level uniformly through the fall and winter so that at its lowest point the spring freshet starts once again.

The drawdown and fill up cycle of Lake Nipigon varies from year to year. It is a function of the inflow and the general power requirements.

Lake Nipigon is considered by Ontario Hydro to be "a major resource in the Northwest Region because of the available large storage and generating capacity. It is used to augment the electrical system resources during generation and transmission outages to maintain system reliability and stability" (ref. F. Benzaquen, Ontario Hydro memo, May 2, 1990).

Water levels of Lake Nipigon were measured at Orient Bay (Water Survey Canada (WSC) No. 02AD003) from 1920 to 1932, and at Macdiarmid (WSC No. 02AD007) from 1927 to present. A graphical plot of the Lake Nipigon maximum, mean and minimum daily water levels, by month, from 1921 to 1990, is contained in Appendix 2A. An example is provided in Figure 2.1.1. The daily water levels at Macdiarmid for 1991 and 1992 are listed in Appendix 2C.

Ontario Hydro operates the gauge at Macdiarmid. Prior to 1992, Ontario Hydro would access the gauge via a telephone link. When called up, the gauge instrumentation would emit a number of "beeps" that corresponded to the water level at the time of the call. Hydro would do this a number of times per day and average the results to get an average daily level (B. Lomenda, Ontario Hydro, 1993, pers. comm.). The baseline level of the gauge was checked against a local benchmark reference about every two years by legal surveyors from Ontario Hydro. This was done to ensure that the baseline level of the gauge was correct.

In 1992, the gauge system at Macdiarmid was replaced with a new system. The new gauge samples the water level more than once per hour. The average hourly data is transmitted directly to an organization in Maryland, USA, via satellite (B. Lomenda, Ontario Hydro, 1993, pers. comm.). Ontario Hydro then obtains the hourly values, via a computer link, and averages them for an average daily water level. This system is to be replaced this year by a more economical direct telephone link between the gauge and Ontario Hydro.

A gauge was installed by Ontario Hydro at Wabinosh Bay in 1986. The operation of this gauge is the same as the present gauge at Macdiarmid. It will remain so as there is no telephone link to the gauge.

The mean, standard deviation, maximum and minimum values and maximum range of daily water levels at Macdiarmid, from 1951 to 1992, are presented in Table 2.1.1b. A further breakdown of the Lake Nipigon level statistics, by decade (i.e., 1951-60, 1961-70, 1971-80, 1981-90) is provided in Appendix 2B. The percentage of time, by month and decade, that the water levels were less than or exceeded certain values is also in Appendix 2B.

2.1.5 Ogoki Diversion

The Ogoki River lying in the north of Lake Nipigon (see Figure 1.1.1) flows east into the Albany River which in turn flows into James Bay. However, the headwater of Ogoki River has been controlled by Ontario Hydro's Summit and Waboose Dams and the water has been diverted into the Lake Nipigon Basin. Hence, the Ogoki River basin can be considered as a sub-basin to the whole Nipigon River basin. The drainage area of the Ogoki River basin that contributes into Lake Nipigon is about 13,578 km^2.

In 1940; construction commenced on the Ogoki diversion which was first suggested in 1923 (Near, 1982, cited in Wilson, 1991). The diversion was constructed to provide greater opportunities for hydroelectric power generation in the Nipigon River and down through the Great Lakes (i.e., the Great Lakes Paper Stations at the Sault; the Decew, Canadian Niagara Power, Sir Adam Beck, and Ontario Power plants on the Niagara River; the R.H. Saunders plant at Cornwall; and Quebec Hydro's plants on the St. Lawrence River (B. Lomenda, Ontario Hydro, 1993, pers. comm.)) and to facilitate transport of pulpwood logs. Water that once flowed north to James Bay is redirected south down the Little Jackfish River to Ombabika Bay at the northeasterly end of Lake Nipigon. The Ogoki Diversion increased water flow in the Nipigon River from an average mean discharge of about 227 m^3/s to 340 m^3/s (Near, 1982, cited in Wilson, 1991).

The main diversion dam is located about 193 km (120 miles) up the Ogoki River at the Waboose Rapids. Waboose Lake is connected by a narrow channel to Mojikit Lake, which in turn is connected to North Summit Lake. These three lakes form the Ogoki Reservoir. Flow into Lake Nipigon from the Ogoki Reservoir is through the Summit Control Dam, and flow into the Ogoki River is through the Waboose Dam. Normally the Summit Control Dam remains open year around and has a maximum capacity of 457 m^3/s. The diversion flow into Lake Nipigon must not exceed 113 m^3/s (Ontario Hydro's Technical Directive No. HO 849-R1) when Lake Nipigon's level is above 260.3 m (854.0'). When the level is above 260.45 m, the diversion must be shut off. In this case, inflow is to be passed at Waboose Dam into James Bay via the Ogoki River. The total capacity of Waboose Dam is about 1,890 m^3/s.

A graphical plot of the maximum, mean and minimum daily flows into Lake Nipigon from the Ogoki diversion, by month, from 1943 to 1990, is contained in Appendix 2A.

2.1.6 Precipitation

The total precipitation inputs into the Nipigon River Basin may be represented by the precipitation data collected at the AES Climate Station (No. 6040325) - Armstrong Airport. The station is located in the middle of Nipigon/Ogoki Basin at an elevation of 320 m. Forty-five years of daily data has been recorded from 1938 to 1982. Using this data set, the average annual precipitation is computed to be 754 mm with standard deviation of 142 mm. The maximum annual precipitation amount is 1010 mm and the minimum is 347 mm. The monthly variation of precipitation was also computed and listed in Table 2.1.3.

2.2 FISHERIES

This section provides a brief overview of the existing status of the fisheries within Lake Nipigon and the Nipigon River. The two waterbodies are discussed separately within the context of this report because the presence of hydroelectric dams acts as a barrier to upstream migration of fish so the fish communities are becoming more distinct. Also, it is more meaningful to discuss the potential impacts of water fluctuations on the lake and river separately (see Chapter 4, section 4.5).

In this report considerable attention is given to brook trout directly. The intent of this study is to develop a preferred water management plan for the Nipigon area. Fish are considered one of the major resources or stakeholders within the system, and brook trout are generally considered the most sensitive fish species to water level fluctuations. Therefore, other species existing within the system are not intentionally overlooked, but rather, the brook trout are being considered as the "sentinel species", and is hoped that water management strategies that protect brook trout will also protect other species with similar habitat requirements. A notable exception to this assumption would include northern pike within Lake Nipigon which spawn in shallow weed beds very early in the spring. The potential impacts of water management options on pike should also be considered.

A second note is made with regard to nomenclature. Brook trout, *Salvelinus fontinalis,* have also been referred to as brook char. We recognize this terminology but for consistency with other documentation within the Remedial Action Plans will continue to use the term brook trout.

2.2.1 Lake Nipigon Fish Community

Lake Nipigon is a large, deep oligotrophic (coldwater) lake. The lake's large size (4,500 km^2) and extensive shoreline provide a great variety of habitat for fish, including both warmwater and coldwater species. Table 2.2.1 lists some of the common fish species found in the lake. Barriers to fish movement on the Nipigon River have prevented many of the non-native species now found in Lake Superior, such as sea lamprey, alewife, rainbow trout and various species of pacific salmon, from reaching Lake Nipigon. Rainbow smelt have, however, become established in the lake.

Table 2.1.3 Monthly precipitation variation at Armstrong airport (Station 6040325) 1938-1982

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
MEAN	(MM)	42.4	38.3	40.4	47.5	62.2	90.4	94.2	86.5	87.8	67.7	63.1	44.4
SD	(MM)	22.1	24.2	18.7	25.2	31.4	38.7	34.9	32.1	49.9	38.0	26.9	18.7
MAX	(MM)	115.9	113.8	80.7	114.2	131.1	179.9	178.2	152.1	307.5	163.2	140.1	94.3
MIN	(MM)	10.6	7.9	7.3	3.9	10.1	24.5	23.6	22.4	13.7	13.6	15.4	19.2

Table 2.2.1. Fish Species in Lake Nipigon - 1986-87 (from R.A, Borecky, 1980; R.A. Borecky and T. Riordan, 1982)

Species	Latin Name
Brook Trout	*Salvelinus fontinalis*
Lake Trout	*S. manaycush*
Lake Whitefish	*Coregonus clupeaformis*
Lake Herring/Ciscoe	*C. artedii*
Round Whitefish	*Prosopium cylindraceum*
Rainbow Smelt	*Osmerus mordax*
Northern Pike	*Esox lucius*
Longnose Sucker	*Catostomus catostomus*
White Sucker	*C. Commersoni*
Lake Chub	*Couesius plumbeus*
Spottail Shiner	*N. hudsonius*
Burbot	*Lota lota*
Brook Stickleback	*Culaea inconstans*
Ninepine Stickleback	*Pungitius pungitius*
Trout-perch	*Percopsis omiscomaycus*
Yellow Perch	*Perca flavescens*
Walleye	*Stizostedion vitreum*
Sanger	*Stizostedion canadense*
Johnny Darter	*E. nigrum*
Logperch	*Percina caprodes*
Slimy Sculpin	*C. cognatus*
Brown Trout	*Salmo trutta*

Lake Nipigon supports commercial and sport fisheries. Subsistence fisheries by local First Nations peoples is included within the commercial fishing since most commercial licenses are held by natives. The commercial fisheries accounts for all but a few percent of the total fish harvest for all species on the lake except for brook trout which is not a commercially sought after species. Fish catches by dominant species are summarized in Table 2.2.2 (Savioja, 1985) although the sport catch may be underestimated (R. Swainson, MNR, pers. comm.).

Brook trout, lake trout, walleye and northern pike are the most sought after sport fish (Savioja, 1985; Ritchie and Black, 1988). Other species angled for on a limited basis include lake whitefish and lake sturgeon. Up to the mid 1980's approximately 75% of sport angling pressure on the lake was attributed to fishing conducted by tourist outfitters (Savioja, 1985) but this proportion has gradually declined since then. In 1988 there were 7 charter boat operators and 3 lodge operators operating on the lake.

Table 2.2.2. A comparison by weight of the estimated average annual sport fish harvest by species between 1980 and 1983, and the 1984 reported commercial harvest on Lake Nipigon (From Savioja 1985)

Fish Species	Sport Harvest (kg)	Commercial Harvest (kg)	Sport harvest as % of Total Harvest (kg)
Brook Trout	673	N.A.	N.A.
Lake Trout	100	20,420	0.79
Walleye	774	75,356	1.02
Northern Pike	866	7,667	10.10
Lake Whitefish	55	225,193	.02

A commercial fishery has operated on the lake since 1917 targeting primarily lake whitefish, walleye and lake trout. Other commercially valuable species include lake sturgeon, lake hering, ciscoe, white sucker and sauger. The commercial fishery operates under a licence system with set individual species quotas for lake whitefish, walleye, lake trout and lake sturgeon (Borecky 1984a, 1984b & 1984c). The annual value of the total commercial harvest on the lake ranges between $400,000.00 to $740,000.00 (R.G. Running, District Manager, MNR Nipigon District in letter to E. McLeod, April 14, 1992).

General observations about the fisheries suggest that brook trout catches have declined markedly. In the three year period 1980-1982, for example, the openwater season angling pressure by the charterboat industry was 50 percent directed at brook trout. However, brook trout comprised only about 11% of the total species caught. The catch-per-unit effort by anglers for brook trout declined from 0.2 in 1982 to 0.02 in 1987 (Ritchie and Black 1988). It should be noted that the decrease in catch of brook trout has been accompanied by an increase in catch of lake trout.

Lake Nipigon Brook Trout Spawning Habitat

The Lake Nipigon Fisheries Assessment Unit (LNFAU) conducted spawning investigations on Lake Nipigon in 1969, then regularly through the 1980s (Ritchie and Black, 1988).

Two primary brook trout spawning areas are reported in Lake Nipigon in South Bay and West Bay. An additional spawning shoal was identified in 1987 (Ritchie and Black, 1988). The Ontario MNR took spawn from Lake Nipigon brook trout stocks annually from 1924 to 1931 and periodically thereafter (see Appendix 2D). It is estimated that an average of 1,280,000 eggs were collected annually, representing approximately 457 females. This practice ceased when the Dorion fish hatchery was constructed in 1933.

There has been a drastic decline in the number of adult brook trout using the spawning shoals. In 1931, MNR staff collected spawn from approximately 689 adults females on the West Bay and from 234 females on the South Bay spawning area. In 1982, there were an estimated 92 adults using the West Bay spawning area and only 18 were reported spawning there in 1987. The number of adults using the South Bay area appears to be stable since 1981 at 56-73 spawning adults.

Mature males as young as 2 have been observed on the spawning areas but males and females of age 3 are the most prevalent in the spawning stock. There has been a substantial decrease in the average age of the spawning population. Since age 3 and 4 brook trout are the most common in angler catches, it appears that the majority of brook trout may only spawn once before they are harvested (Ritchie and Black, 1988).

The accurate determination of brook trout redd elevations is critical to examine the impact of water level fluctuations on brook trout recruitment. Ritchie and Black (1988) reported that the elevations for brook trout redds at West Bay, Lake Nipigon ranged from 258.82 - 259.04 m (849.2 to 849.9 ft.). Recent elevations measured at South Bay by the study team on April 29, 1993, indicate the highest redds identified at South Bay are at an elevation of 259.83 m(852.5 ft). This is approximately 35 cm higher than elevations previously reported by the MNR at South Bay. Given this apparent discrepancy it would be appropriate to resurvey the redd elevations at West Bay.

2.2.2 Nipigon River Fisheries

The Nipigon River provides the largest inflow into Lake Superior. The 51 km long river is now characterized by lakes that alternate with turbulent stretches. The largest of the lakes, Lake Helen, differs in that it is not formed by a dam. Fish migration from Lake Superior is blocked at Alexander Falls although downstream passage likely occurs. The area provides varied habitat for fish, ranging from fast flowing riverine habitat to lake habitat. The fish species known to currently occur in the lower river are listed on Table 2.2.3. This list includes a number of exotic species that have become established including sea lamprey, alewife, rainbow trout, and various species of pacific salmon.

Table 2.2.3. Fish Species in the Lower Nipigon River - 1986-87 (from M.E. MacCallum, 1989)

Species	Latin Name
Sea Lamprey	*Petromyzon marinus*
Alewife	*Alosa pseudoharengus*
Pink Salmon	*Oncorhynchus gorbuscha*
Coho Salmon	*Oncorhynchus kisutch*
Chinook Salmon	*Oncorhynchus tshawytscha*
Rainbow Trout	*Oncorhynchus mykiss*
Brook Trout	*Salvelinus fontinalis*
Lake Trout	*Salvelinus namaycush*
Lake Whitefish	*Coregonus clupeaformis*
Lake Herring/Ciscoe	*C. artedii*
Round Whitefish	*Prosopium cylindraceum*
Rainbow Smelt	*Osmerus mordax*
Northern Pike	*Esox lucius*
Longnose Sucker	*Catostomus catostomus*
White Sucker	*C. Commersoni*
Shorthead Redhorse	*Moxostoma macrolepidotum*
Lake Chub	*Couesius plumbeus*
Carp	*Cyprinus carpio*
Emerald Shiner	*Notropis atherinoides*
Spottail Shiner	*N. hudsonius*
Burbot	*Lota lota*
Brook Stickleback	*Culaea inconstans*
Ninepine Stickleback	*Pungitius pungitius*
Trout-perch	*Percopsis omiscomaycus*
Yellow Perch	*Perca flavescens*

Table 2.2.3. Fish Species in the Lower Nipigon River - 1986-87 (from M.E. MacCallum, 1989)

Species	Latin Name
Walleye	*Stizostedion vitreum*
Least Darter	*Etheostoma microperca*
Johnny Darter	*E. nigrum*
Logperch	*Percina caprodes*
Mottled Sculpin	*Cottus bairdi*
Slimy Sculpin	*C. cognatus*

The Nipigon River currently supports a sport fishery only as commercial fishing is not permitted. Subsistence fishing is reportedly to be not all trout prevalent. Fish species sought after include brook trout, lake trout, chinook salmon, coho salmon, rainbow trout, lake whitefish and northern pike. Most of the fishing effort on the lower river is directed towards three species, chinook salmon, rainbow trout and brook trout (Table 2.2.4). Angling for walleye is currently not permitted in the lower Nipigon River, Nipigon Bay, Lake Helen, Polly Lake and the Jackfish River.

General observations about the fisheries suggest that brook trout catches had declined noticeably by the mid 1970s (MacCallum, 1989). Historical catches of brook trout in the late 1800s and early 1900s were quite incredible. Creel surveys conducted in 1987, 1988 and 1992 demonstrate very low catch per unit effort (CUEs) for all anglers with values of only 0.03, 0.05 and 0.005 fish per angler hour, respectively. Brook trout are considered relatively difficult to catch and anglers targeting this species are generally more successful than the average salmonid fisherman. Quantitative CUE data prior to 1987 are not available, although a dramatic decline in brook trout abundance is generally accepted. Other species, including lake trout, walleye and northern pike have also declined, although there have been recent noticeable improvements in the lake trout stocks (MacCallum, 1989).

In addition to the collapse of the walleye fishery in the area, local fishermen have reported a substantial decline in northern pike especially in Lake Helen. The decline is thought to be related to the decreased abundance of macrophytes, or aquatic plants, in the lake. Northern pike spawn early in the spring, shortly after ice-out, in shallow weedy bays. Adult pike rely on aquatic plants and vegetation for cover and feeding habitat. Anectodal observations suggest that the abundance of macrophytes has decreased substantially. Although water level fluctuations do occur under natural conditions, aquatic vegetation is also susceptible to impacts from artificial fluctuations and water drawdown.

Table 2.2.4. Fishing effort and catch-per-unit-effort (CPUE) for various species of fish in the lower Nipigon River, July 21 - November 1, 1988 (From MacCallum 1989).

Fish Species	CPUE	Effort (hrs)	Total estimated harvest (no. fish)
Brook Trout	.051	2024	135
Lake Trout	.355	224	133
Coho Salmon	.084	117	10
Chinook Salmon	.094	1779	173
Rainbow Trout	.146	3731	552
Lake Whitefish	1.762	86	170
Walleye	.154	32	5

Recently introduced pacific salmon species and rainbow trout have become abundant in the river. If the Nipigon River follows the trend seen on other large tributaries of Lake Superior, such as the Michipicoten River, further increases in these stocks will likely occur.

Nipigon River Brook Trout Spawning Habitat

Optimal brook trout riverine habitat is characterized by clear, cold spring fed water; a silt-free rocky substrate in riffle run areas; an approximate 1:1 pool to riffle ratio with areas of slow, deep water; well vegetated stream banks; abundant in stream cover; and relatively stable water flow, temperature regimes and stream banks (Raleigh, 1982).

Installation of the dams and regulations of flow rates have severely changed the Nipigon River from its natural state. The most apparent changes are that water flows are no longer stable. The fluctuation of flow rates promote erosion as water levels fall and rise. Increased erosion elevates turbidity levels. Brook trout feed primarily by sight and increased turbidity may interfere with normal feeding activity of those trout resident in the river.

Nipigon River brook trout have only been observed to spawn in shallow water close to the banks of the river, and parameters which describe the microhabitat of the whole channel do not well represent the microhabitat of the known spawning beds. Brook trout have been observed to spawn at three locations between Alexander Falls and Lake Helen. These include: 1) Alexander Backpool, 2) Paramacheene, and 3) Gapens Pool.

The MNR, in conjunction with Ontario Hydro, have conducted detailed studies of brook trout spawning redds relative to water elevations under different flow conditions at these sites. The three primary sites are briefly described here as adapted from Pope and Metcalfe (1991, Draft Report). Water level elevations at under different flow regimes are illustrated in Figure 2.1.3.

Alexander BackPool

The spawning area is immediately below the dam in the original river channel. The total area (approximately 5 ha) is the former splash pool of the natural falls. The pool is now near stagnant but much natural upwelling does occur. Brook trout have been observed to spawn over a gravel finger at the southeast end of the pool from the river connection. The origin of the gravel terrace is unknown. Adjacent to the gravel terrace is a steep forested hill. At the base of the hill, many upwelling springs occur about 0.3 to 0.6 m in diameter in the sandy/silt substrate of the river bottom.

Hydraulic data indicate that the elevation of water in the old channel is very close to that of the tailrace of the station and that response is rapid. At 540 m^3/s, the embayment is completely flooded. However, there is no current in the embayment even at this discharge. A shallow constriction between the dam and a bedrock outcrop forms a narrow channel (less than 10 m wide) which eliminates current effects from the river.

At 350 m^3/s, there is only slight exposure of the river bed resulting in four small gravel bars. The perennial woody shrubs that cover these bars at this elevation indicate that this is the normal upper limit of flooding.

At 260 m^3/s, most redds are still underwater. This is about the minimum level of discharge for providing good protection of redds created at 350 m^3/s. Water elevation at 260 m^3/s was 185.15 m and three of four surviving redd markers were at elevations 184.94 to 185.31 m (elevations from Pope and Metcalfe, 1991, draft).

At flows of 170 m^3/s, there is substantial exposure of the spawning area. All but one (at 184.05 m) redd would be exposed. At 113 m^3/s, this whole area is dry, and very little wetted area is left within the whole embayment.

In summary, spawning redds occur at elevations of approximately 184.4 to 185.31 m at this location. Water levels for flows of 113 m^3/s and 350 m^3/s are 184.04 m and 185.81 m, respectively (Figure 2.1.3). Therefore all known redds would be exposed at 113 m^3/s.

Paramacheene Bridge Spawning Site

MNR has collected detailed information on this spawning bed which is approximately 6 km downstream of the station. The spawning area (about 15 x 8 m) is located at the end of a large pool (about 200 m wide) just upstream of the Paramacheene railway bridge. Brook trout spawning has been observed over fine gravel and sand substrates very close to the bank where the main flow of

the river divides into downstream and upstream (backwater) components. Springs are conspicuous at lower river discharges.

Active redds are at elevations of approximately 184.2 m At 350 m^3/s, the water level is about 185.17 m and there is no exposed river bed (Figure 2.1.3). The first redd becomes exposed at about 170 m^3/s.

This spawning bed has a heterogeneous substrate comprised of a complete range of particles from small boulder to coarse sand. However, spawning occurs over the fine gravel and coarse sand at spring locations. Springs are not visible until river discharge drops to 170 m^3/s when river elevation is between 184.19 and 183.96 m. At 113 m^3/s, many of these springs are no longer conspicuous or issue from new locations closer to the waters edge. Studies by Currey *et al.* (1992) suggest that the springs still occur at the same elevation, but would now flow underneath the gravel and appear closer to the waters edge.

Just downstream from this spawning bed is a typical till outcrop that extends as boulder/cobble points into the river. At low discharges, this point almost reaches a boulder/cobble shoal that becomes exposed just upstream from the middle columns of the Paramacheene Bridge. Chinook salmon spawn in the shallows of this area. To protect brook trout spawning, MNR has created fish sanctuaries at this location, Alexander backpool and Gapens pools, and no angling is allowed during the brook trout spawning season.

The importance of these shallow boulder/cobble areas as centres for secondary production in the river are indicated by the high concentrations of hydropsychid caddisfly larvae and other benthic invertebrates and fish. The caddisfly larvae are unable to retreat to deeper water when water levels fall rapidly, typical of a daily peaking regime, and millions of them become exposed. However, at cool temperatures, many were found to survive on the wet undersurface of the rocks for at least two days (Pope and Metcalfe, 1991, draft). Sculpin (*Cottus coqnatus*), were also found among the rocks. These small fish, known by locals as "cockatouche", are reputed to be an important prey of mature brook trout (Wilson, 1990).

Gapen's Pool

Gapen's Pool lies just downstream of the outlet of Lake Helen about 15 km downstream of Alexander Falls GS. It lies on the east side of the river upstream of the Highway #17 bridge. It is a backwater pool with the flow directed upstream. Sand deposition in the centre of the pool has created sand bars on which weeds grow. At this point, the river has a concise bank bounded by a high, steep, eroding, sand hill. It is a popular angling location for fishermen as it is easily accessible from the highway. MNR and anglers have previously observed brook trout spawning in shallow water along the shoreline.

Brook trout redds at this site are between elevations of about 182.71 to 183.7 m. At 113 m^3/s the river elevation is 183.21 asm (Figure 2.1.3). In 1989, brook trout spawned at about 350 m^3/s in depths of water ranging from 0.24 to 1.25 m.

2.2.3 Historical Habitat Changes

Major changes and activities have reduced the suitability of Lake Nipigon and the Nipigon River as habitat for brook trout. These changes were reviewed by MacCallum (1989) and include:

- increased flow rates as a result of the Ogoki diversion in 1943;
- installation of dams at Cameron Falls (1920), Virgin Falls (1925 -- now breached), Alexander (1930) and Pine Portage (1950) and the flooding of extensive stretches of the river;
- alteration of water levels on Lake Nipigon;
- alteration of water flow rates on the Nipigon River;
- use of biocides on the river to control blackfly and Sea Lamprey;
- log drives between 1923 and 1973;
- channel modifications including dredging of the river between Helen Lake and Alexander, installation of highway and railway bridges, and installation of pipelines crossings;
- degradation in water quality in Nipigon Bay as a result of municipal and pulp mill effluents;
- changes in the fish assemblage, most notably the introduction of rainbow smelt (*Osmerus mordax*), rainbow trout (*Salmo gairdneri*), brown trout (*Salmo trutta*), coho salmon (*Oncorhynchus kisutch*), pink salmon (*Oncorhynchus gorbuscha*) and chinook salmon (*Oncorhynchus tshawytscha*); and
- commercial and sport fisheries active since the late 1800s.

As a combined result of these activities, the brook trout fishery has declined drastically in both Lake Nipigon and the Nipigon River. In addition there have been marked declines in the populations of walleye and northern pike in the area. Rehabilitation of the brook trout, walleye and pike fisheries has been established as a priority for the Ontario Ministry of Natural Resources (Ministry of Natural Resources, 1989). One of the primary issues in the rehabilitation of brook trout, and the focus of this report, is water flow management practices on the Nipigon River and related water level management practices on Lake Nipigon.

Ontario Hydro manages the flows in the Nipigon River by controlling discharge from Lake Nipigon and the Ogoki diversion. When water flow in the Nipigon River changes, a number of other variables are affected including flow velocity, water depth, river width, and wetted perimeter. The effects of fluctuations in river flow rates are most pronounced in the portion of the river between Alexander Falls and Lake Helen and in the short stretch of river between Lake Helen and Nipigon Bay. Jessie Lake, which acts as a reservoir for Cameron Falls GS, is also affected by the fluctuations.

The fluctuating flow rates in the river are shown to:

- expose brook trout redds during low flow events (Wilson, 1991);
- affect ground water flow through redds (Curry *et al.*, 1992);
- exacerbate instability of the shoreline and stream bank erosion (Wilson, 1991; Trow, 1992; Radhakrishna et al., 1992); and
- reduce abundance and diversity of benthic biota inhabiting substrates prone to exposure during low flow events (Pope and Metcalfe, 1991, draft).

The primary objectives of this portion of this study are to:

1. ascertain the effect of existing water management practice on fish and fish habitat in Lake Nipigon and the Nipigon River; and
2. generate water management options to protect or enhance the existing fishery.

Within the context of this discussion, we focus on brook trout as the fish species of prime importance. Brook trout are used as an indicator of general aquatic ecosystem health, and it is assumed that other fish species will be protected by following management practices that protect the brook trout.

The original intent of this study was to examine the impact of water level fluctuations on brook trout production. However, we felt it was also important to identify other activities that have occurred or are now occurring in the system that could impact the fisheries. The relative importance of these events were considered within a framework for Cumulative Effects Assessment (CEA) (Figure 2.2.1).

2.3 USERS

The primary users of the Nipigon watershed related to the fisheries include:

- the **fish**;
- **wildlife** (for example otter, mink, eagles, osprey, herons, cormorants)
- **subsistence fishermen**;
- **anglers**; and
- **commercial fishermen**.

The fish and fishermen have been discussed in Section 2.2, Fisheries. Other users of the Nipigon system are outlined in this section.

2.3.1 Wildlife

Wildlife diversity in the area is limited to species well adapted to harsh environment. Such species include black bear, timber wolf, moose, deer, fox lynx, fisher, marten, mink, muskrat, beaver, porcupine, skunks, snowshoe hare, red squirrel, shrews, mice, voles and various species of upland game birds and songbirds. Eagles, osprey, herons, cormorants and ducks rely heavily on a healthy fisheries. In recent years, large numbers of eagles have become visible along the Nipigon River during the salmon runs.

A program to establish Canada geese in the Nipigon area was initiated by Ducks Unlimited in the summer of 1989. The initial phase of the introduction was successful: Canada geese are common in the area during ice-free season.

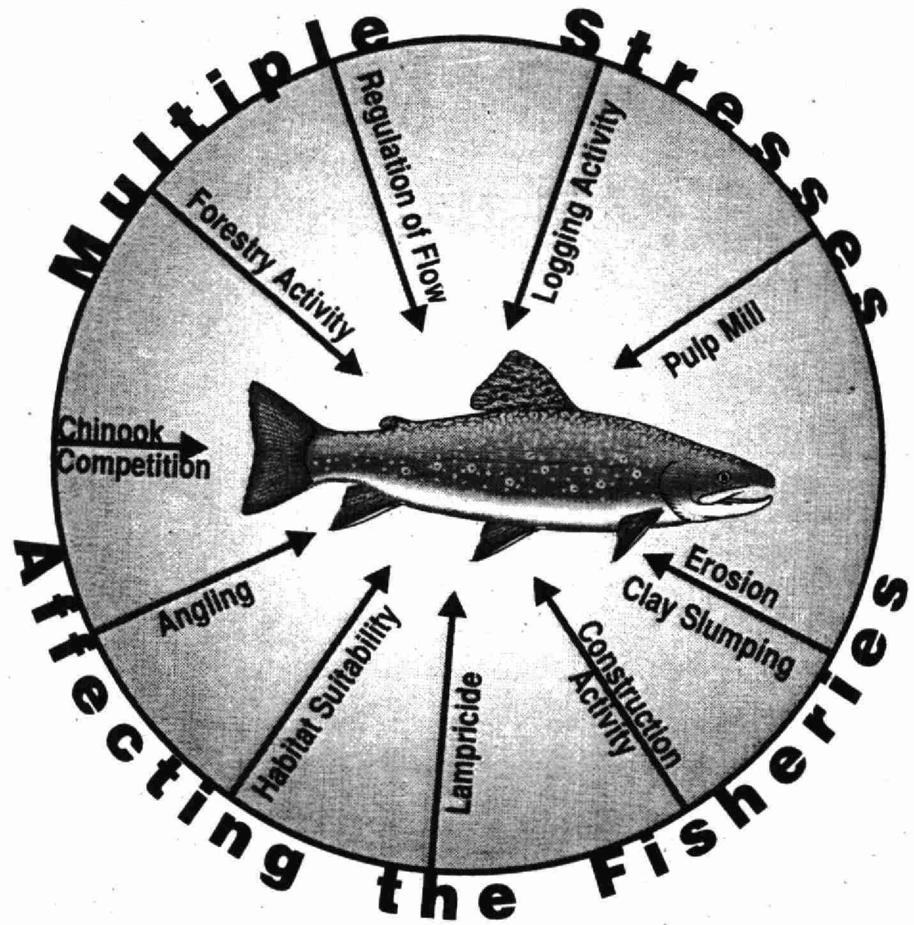


Figure 2.2.1 **Framework for cumulative effects assessment**

The broad objective of Ministry of Natural Resources' wildlife management plans is "to provide sustained optimum cultural, social and economic benefits to the people of Ontario". In the Nipigon Bay area, white-tailed deer, moose and black bear, which are prized by hunters and wildlife enthusiasts, are the focus of wildlife management strategies (RAP, 1991). Special protection is afforded to eagle, osprey and heron nest sites.

2.3.2 First Nations

The archaeological record indicates that the shores and river mouth of Lake Nipigon have been occupied for some 4,000 years (Waters, 1987, in Wilson, 1991). The First Nations people have used the land and water of the Nipigon for hunting, fishing, and harvesting food and medicines. Burial grounds and offering rocks are sacred places along the shoreline.

Native people have relied on fish from the lower river and Lake Helen for food since time immemorial and continued to do so until fish populations declined in recent decades (MacCallum, 1989). Diaries of early Europeans in the area commented on extensive fall fishing by natives: the fish were preserved as a major source of food for the winters. Guiding on the river was a major activity and source of income during the late 1800's and early 1900's.

The First Nation Bands presently have a significant interest in the commercial fishing operations on Lake Nipigon.

2.3.3 Tourism/ Recreation

The Nipigon area has noteworthy aesthetic value, with its rugged shoreline islands and archaeological and historic sites. Areas of the shoreline are used as scenic lookouts and for hiking, camping and nature appreciation. Lake Nipigon and the lower Nipigon River is used regularly for boating and sport fishing. Some people come just to watch the fish spawn.

Much of the tourism is based on the natural beauty of the Nipigon River watershed and the angling and dates back well into the 19th century. Early recognition of the value of the scenic beauty is demonstrated by the urging, in 1901, for the reservation of an additional strip of land on each side of the Nipigon River, in addition to the one chain already reserved to protect the scenery (Annual Report of Fisheries Branch, 1901, cited in Wilson, 1991). In the *Nipigon River Corridor Concept Planning Study*, Moore/George (1991) stated that "the most important tourism attraction the area has to offer is its landscape". The study further identified that "at present, the tourism season is essentially limited to the summer months."

There are about eight operators who offer fishing and sightseeing cruises on Lake Nipigon, three cabin/ lodge operators on the lake and one campground operation on Lake Helen. They rely on the scenic beauty (i.e., viewing of shoreline, beachcombing), a sound sport fisheries, and an overall clean environment to keep the customers coming back.

2.3.4 Hydro-electric Power

As discussed in Section 2.1, there are three Ontario Hydro generating stations operating on the Nipigon River. Pine Portage, which operates four generators, was constructed in 1950 and operates with an efficiency flow rate of 398 m^3/s. Cameron Falls was the first hydro-electric station and was constructed in 1920. Seven generators are operated at Cameron Falls with a 347 m^3/s efficiency flow rate. The third and most southerly generating station, Alexander, was constructed in 1930. Currently five generators are operational with an efficiency flow rate of 406 m^3/s. Total combined capacity for all three generating stations is 275.2 megawatts (MW) under maximum flow conditions. The total station discharge, output and economy factor at normal head for all three generating stations are summarized from Ontario Hydro's Technical Directives No. HO 851, HO 852-R1 and HO 853 and are listed in Table 2.3.1.

Table 2.3.1 Summary of Nipigon Hydro-electric System

	Pine Portage	Cameron Falls	Alexander	Total
Normal Head (m)	31.7	22.3	17.4	
At Efficiency				
Discharge (m^3/s)	397.2	348.8	407.0	
Output (kW)	108,700	64,700	62,200	235,600
Economy Factor ($kW/m^3/s$)	273.7	185.5	152.8	612.0
At Maximum				
Discharge (m^3/s)	530.6	462.5	472.5	
Output (kW)	130,500	77,480	66,470	274,450
Economy Factor ($kW/m^3/s$)	245.9	167.5	140.7	554.1

2.3.5 Shore Property Owners

The various shoreline property owners are as follows:

Lake Nipigon

- Gull Bay First Nation, Gull Bay Reserve, Gull Bay;
- Rocky Bay First Nation, Rocky Bay Reserve, Pijitawabik Bay;
- residences and cottages in Macdiarmid;
- approximately 70 cottages, homes and lodges at Poplar Point, Sand Point, Pijitawabik Bay and Orient Bay;
- MNR operations base at Postagoni River mouth on Pijitawabik Bay;
- CN Rail;
- federal and provincial governments.

Nipigon River

- Red Rock First Nation, Lake Helen Reserve, Lake Helen;
- cottages, Polly Lake, and one campground operation, Lake Helen;
- Towns of Red Rock and Nipigon;
- CN Rail and CP Rail;
- federal and provincial governments.

The shoreline property owners "use" of the shoreline is tied to their ownership and investment in their properties and to their quality of life (i.e., enjoyment of the shore and water, recreation). Many of the owners have invested in structures such as docks, breakwaters, launching ramps, shoreline protection (i.e., rip rap revetments, timber walls).

2.3.6 Railways

Construction of the National Transcontinental Railway along the north end of Lake Nipigon helped to open up the Nipigon River watershed for development. While the railway was being built, the primary means of transportation for workers and supplies was the Nipigon River and Lake Nipigon. Roads, bridges and portages were built.

Starting about 1908, the Nipigon Tramway (narrow gauge railway) ran 29 km from Alexander Landing to South Bay on Lake Nipigon. Flat cars were loaded onto barges at Nipigon and towed up Lake Helen and the Nipigon River. At Alexander Landing, they were offloaded and pulled on the Tramway to South Bay where they were again loaded onto barges for the 110 km trip to the northern depot on Ombabika Bay (Todd, 1977, cited in Wilson, 1991). Winter roads were used after freeze-up to transport supplies.

In 1910, construction began on the Canadian Northern Ontario Railway which is now part of the CN Railway. This railway also gave new access to the Nipigon River system resulting in increased tourism (Todd, 1977, cited in Wilson, 1991). The CN tracks head northwest out of Nipigon and along the southwest shore of Lake Helen. They proceed up the west side of the Nipigon River until

they cross the river at Parmacheene and then follow the east bank until past Alexander GS. From there it heads off towards Orient Bay where it closely follows the east shore of Orient Bay and Pijitawabik Bay. The CN tracks head south out of Nipigon along the west shore of the Nipigon River.

The CP tracks cross the Nipigon River at Nipigon adjacent to Highway 11/17.

2.3.7 Forestry and Logging

Forests in the Nipigon River area are typical of the boreal forest region, ranging from mixed deciduous-coniferous to single-dominant coniferous types. Forestry dates back to the construction of the Canadian Pacific Railway in the 1880's. The demand for railway ties peaked between 1883 and 1885. A similar demand for rail ties occurred with the construction of the National Transcontinental Railway in 1908-1910 and the Canadian Northern Ontario Railway in 1913-1915. In 1945, the production of pulp and paper products began at the Red Rock mill, known today as Domtar Packing Ltd. Logs were driven down major waterways in the area until the early 1970's (RAP, 1991).

The logging industry has played a major role in the economic development of the area. In the 1911 Annual Report of Game and Fisheries (cited in Wilson, 1991), it was reported that the Government had advertised timber berths for sale on Lake Nipigon. Log drives were conducted on the Nipigon River from 1923 to 1973 (Wilson, 1991b). During this period, a number of forestry companies were involved in running from 200,000 to 400,000 cords of wood per year down the Nipigon River to mills on Lake Superior. The drives began at ice out on the river and continued throughout the summer. Logs were collected and stored above Virgin Falls and then run down the river past Pine Portage. The logs were then stored in booms between Split Rock and the narrows above Jessie Lake. The log booms were towed down Jessie Lake by tug and stored above Cameron Falls. From there the logs were run to Lake Helen where they were stored and then run again (D. Nuttall, 1993, pers. comm.) to Nipigon Bay where they were collected and towed to various mills on Lake Superior.

Water levels on the rivers were commonly controlled by one or more dams and the stream beds themselves were altered when dredging was carried out and obstacles to the logs were cleared away (Lawrie and Rahrer, 1973, cited in Wilson, 1991). Rock filled cribs were constructed along the river banks for landings.

In 1937, boom timber was being cut for the first water drive on Lake Nipigon (Mihailovic, 1973, cited in Wilson, 1991). The first shipment of logs arrived at Virgin Falls in September, 1938 (OMNR , 1973 in Wilson, 1991). Major timber harvests began in 1939. Logs were driven down the Ombabika and Onaman Rivers to Lake Nipigon, boomed and towed down the lake and then run down the Nipigon River. The Ombabika River was used for log drives from 1939 to 1963 and the Onaman River from 1939 to the early 1970's (Gollat, 1975, cited in Wilson, 1991). Logging operations were carried out on the east and west shores of Shakespeare Island and on the northwest shore of Kelvin Island (Gollat, 1975 in Wilson, 1991).

In 1936, the Lake Sulphite Pulp Company began construction of the Red Rock mill, known today as Domtar Packaging Ltd. In 1945, construction was completed and the production of pulp and paper products began. The Red Rock mill was taken over in 1952 by the St. Lawrence Corporation and in 1961 by Dominion Tar and Chemical (later Domtar Packing Ltd) (RAP, 1991).

In 1945, the Domtar mill produced unbleached kraft pulp. In 1948, a groundwood pulp mill was constructed and a paper machine for the production of kraft linerboard was added in 1954. The original paper machine was converted to the production of newsprint from groundwood. Until April, 1992, the Domtar mill was a dual product mill with an average daily production of 210 tonnes of newsprint and 620 tonnes of kraft linerboard (RAP, 1991). Since April, 1992, Domtar produces only linerboard (R. Clark, Domtar, 1993, pers. comm.). Production in the first quarter of 1993 has been 674 tonnes/day.

In 1974, log drives ceased on the Nipigon River. Economic reasons as well as increasing public pressure for a cleaner environment influenced the change from river driving to trucks hauling the logs (Annual Report Fish and Wildlife, 1973-74; cited in Wilson, 1991).

2.3.8 Urban Development and Agriculture

Because of the importance of the fur trade and fishing to the early economy of the area, initial development took place along the shores of the Nipigon River. With the decline of these activities and the increased reliance on the overland transportation routes, recent urban development, centred primarily in the town of Nipigon (population of approximately 2,400), has expanded inland. The community of Red Rock (population of approximately 1,400) developed around the Domtar Pulp and Paper Mill. Nipigon and Red Rock use separate landfill sites for municipal wastes. Both sites are located more than five kilometres inland from Nipigon Bay.

Smaller communities are also located near Lake Nipigon and the Nipigon River. The Lake Helen reserve of the Red Rock First Nation is located on Lake Helen. The Rocky Bay First Nation and the community of Macdiarmid are located on Pijitawabik Bay (on Lake Nipigon). The community of Beardmore is located inland from Lake Nipigon. The Gull Bay First Nation is located on the west side of Lake Nipigon. Additional First Nation communities may develop around Lake Nipigon (B. Hudson, MNR, 1993, pers. comm.)

Agriculture potential in Nipigon is poor as a result of a short growing season and thin soils over bedrock. The frost-free periods is only 70-100 days per year.

2.3.9 Industrial/Municipal Intakes and Water Pollution Control Plants

As noted in Section 2.3.7, Domtar Packing Ltd. in Red Rock had been a dual product mill. It had a bleachery, producing approximately 70 tonnes of bleached product per day. Bleached products had made up 8.3% of the total production (RAP, 1991). However, since April, 1992, Domtar has only been producing linerboard. No bleaching is done. In the first quarter of 1993, Domtar has discharged 80,242 m^3/day of effluent to the receiving waters (R. Clark, Domtar, 1993, pers. comm.).

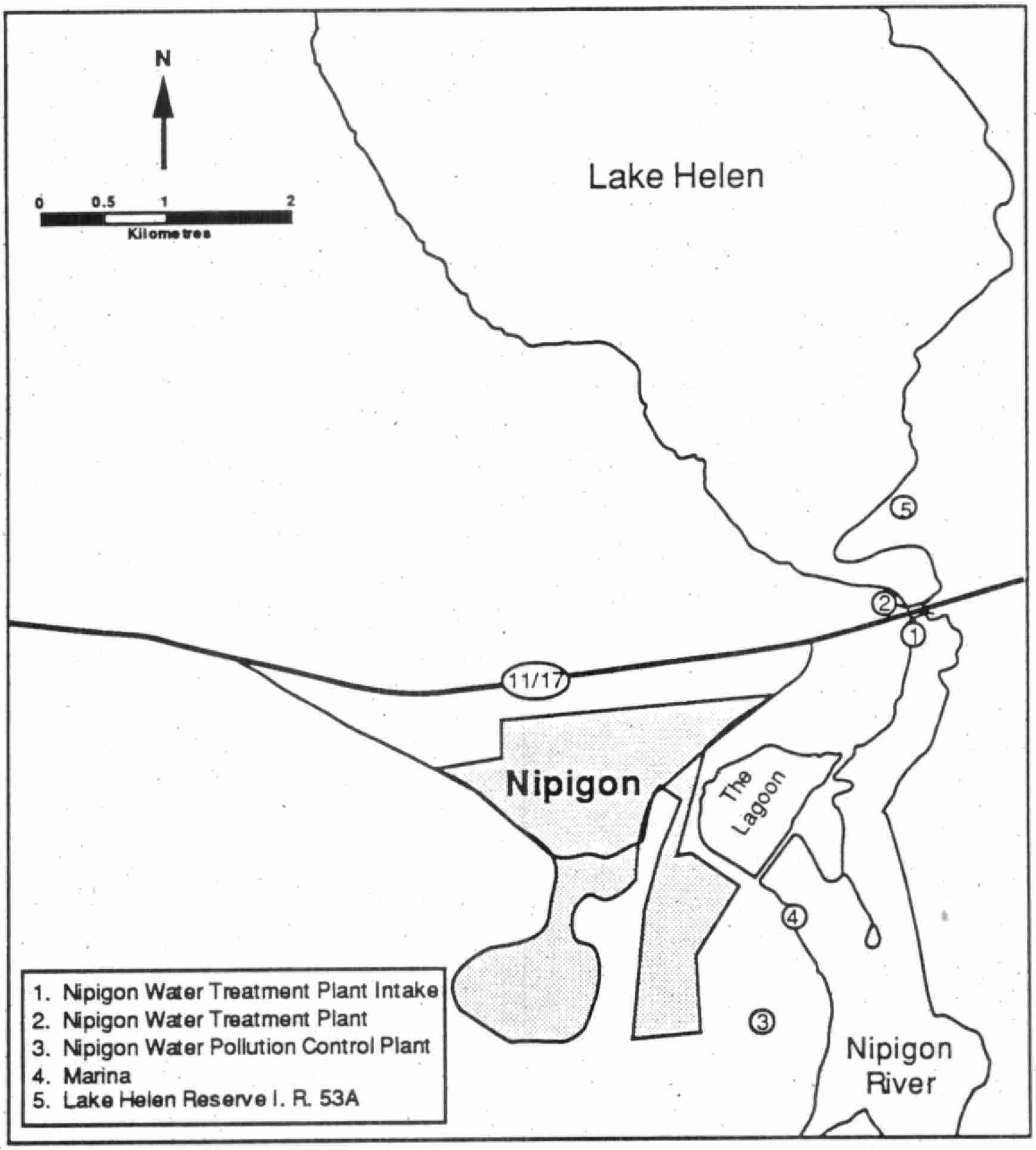
There is no bypassing and the effluent is monitored for regulatory purposes.

The Township of Red Rock draws 1,000 m^3/day of water from Nipigon Bay. The Township of Nipigon draws an average of 1,600 m^3/day of water from the lower Nipigon River near the Highway 11/17 bridge. Drinking water is filtered and chlorinated before distribution to Red Rock and Nipigon residents. The Community of Lake Helen draws drinking water from Lake Helen. Water is treated before distribution.

The Township of Nipigon (population of approximately 2,400) ran a small sewage treatment plant until 1976. Because it was incapable of meeting the needs of the growing population, it was replaced with a 1,630 m^3/day primary treatment plant. This upgrading doubled the capacity of the system - flows increased by 60% from 1978 to 1982 (RAP, 1991). The effluent is discharged to the Nipigon River west of the Nipigon marina.

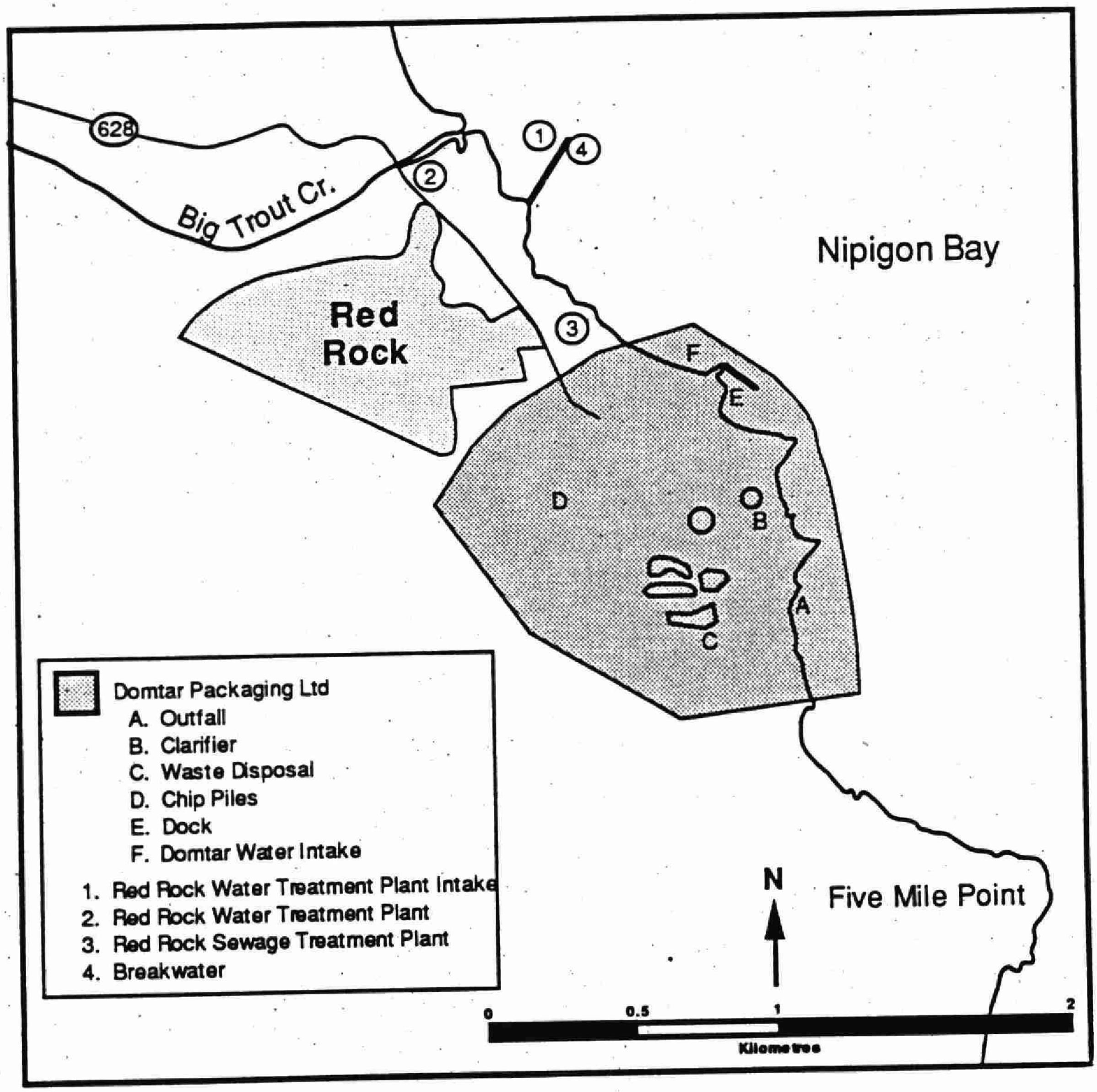
The Township of Red Rock (population of approximately 1,400) operated an adequate communal septic tank system until 1978. This system was replaced by a primary treatment plant with a capacity of 1,270 m^3/day. Prior to November 1989, the Red Rock water pollution control plant (WPCP) discharged in conjunction with the Domtar mill. The WPCP now discharges separately into Lake Superior.

Figures 2.3.1 and 2.3.2 show the intakes and the WPCP's in Nipigon and Red Rock respectively.



(from RAP, 1991)

Figure 2.3.1 **Nipigon townsite and surrounding area**



(from RAP, 1991)

Figure 2.3.2 **Red Rock townsite and surrounding area (September 1989)**

3.0 PUBLIC CONSULTATION

3.1 APPROACH

This study is not just a data collection or pure research exercise. The development of water quantity management options are being based on the following objectives:

- Recommended options are to reduce, if not eliminate, conflicts identified by major stakeholders and the general public.
- The preferred option and implementation process are to be arrived at through a community consensus-building process.

Whether meeting with stakeholders one-on-one or discussing issues at public sessions, resolving conflicts and building a consensus is central to the success of this project. The members of the study team have strived to design a consultation program which identifies and resolves conflicts, and enhances the potential for developing a community consensus.

3.2 PUBLIC CONSULTATION ACTIVITIES

The preferred option for managing the flows and water levels in the Nipigon system will be arrived at through extensive public consultation. As stated earlier, the overall consultation approach is to reduce conflict and undertake consensus building throughout the study. The specific public consultation and supporting communication activities undertaken to date include:

- contact with the stakeholders, through face-to-face and telephone interviews, group meetings, and receipt of written and other (i.e., photographs) submissions, to identify conflicts and issues;
- mailings of three "Update" newsletters (Fall 1992, February 1993, and April 29, 1993) to the stakeholders who have been in contact with the study team and others who have requested to be put on the mailing list;
- an article about the project was written for placement in the Nipigon Bay RAP newsletter; and
- advertising for the public meetings in June.

The contact with the stakeholders is discussed in Section 3.3.

The first two "Update" newsletters outlined the background and scope of the study, preliminary findings and the next steps in the study. Also, questions and comments were invited. Copies of these two "Update" newsletters are provided in Appendix 3A.

The April 29, 1993 "Update" (see Appendix 3A) announced the impending release of this report along with notice of the public meetings to be held in June, 1993, and the formation of a community-based Nipigon River Water Quantity Management Working Group. The draft Terms of Reference for the Working Group are provided in Appendix 1A.

A copy of the article for the Nipigon RAP newsletter and the draft text of the advertisement for the public meetings is presented in Appendix 3A.

As outlined in Chapter 1 of this report, public consultation, including public meetings, will continue through the second year of the project.

3.3 STAKEHOLDER CONTACTS

3.3.1 General

Throughout the fall of 1992, the study team interviewed Nipigon River watershed stakeholders to identify their concerns with respect to present and future water quantity management and to learn more about, confirm, and expand the list of known conflicts in water uses. The interviews took the form of face-to-face discussions and group meetings over the course of four separate visits to the area. Additional interviews were conducted by telephone. Written and other submissions were also received and a number of individuals subsequently requested copies of the newsletter updates. Stakeholders were also provided with the telephone and fax numbers of the study team project manager and were invited to contact the team if they had any further questions or comments.

An initial list of potential stakeholders was provided in the Terms of Reference. To date, approximately 90 people have been in touch with the study team. The breakdown of the stakeholder contacts is given in Table 3.3.1. A list of the stakeholders who have been in contact with the study team is provided in Appendix 3B.

Table 3.3.1 Summary of Stakeholder Contacts

Type of Contact	Number of Stakeholders†
Face-to-face interviews	38
Group meeting	32
Telephone interviews	3
Written & other submissions	4
Additional requests for newsletter	20

† a number of people were involved in two or more types of contact (i.e., interviewed and also attended group meeting)

3.3.2 Stakeholder Interviews

The interview visits to the Nipigon watershed were carried out on August 26 to 28, September 16 to 18, October 28 to 30, and December 3, 1992. The stakeholders were first contacted by telephone to explain the nature of the study and the purpose of the interview and to arrange a suitable date and time. In most cases, a list of questions that would be discussed during the interview was provided prior to the interview. A copy of these questions is provided in Appendix 3C.

The interviews took place at the stakeholder's home or workplace and was attended by one or two members of the study team. Some group meetings were held in local halls (i.e., Beardmore, Red Rock First Nation and Red Rock).

3.3.3 Stakeholder Comments

The stakeholders provided a wealth of information regarding the Nipigon watershed along with an expression of their concerns and preferred options. It is beyond the scope of this report to repeat everything that each of the stakeholders told the study team. However, in this section, the team has attempted to provide a representative sampling of the information, comments and opinions provided by the various stakeholders. For reporting purposes, an attempt has been made to combine the stakeholder's comments into similar interest groups. However, it must be remembered that most of the stakeholders have interests in many aspects of the resources and ecosystem of the Nipigon watershed.

*Please note that these comments are the **opinions and viewpoints** of the various individual stakeholders at the time of the interviews.*

<u>Nipigon River</u> (including Polly Lake and Lake Helen)

<u>General</u>

- The present flow restrictions at dams are the cumulation of concerns regarding erosion of the shoreline, the 1990 landslide, and fish habitat destruction.

<u>River Fisheries</u>

- Anglers fish the river in the summer and fall; salmon fishing is important during the fall.

*Please note that these comments are the **opinions and viewpoints** of the various individual stakeholders at the time of the interviews.*

First Nations/ Traditional Lifestyles

Note: Comments provided by individuals of the various First Nation Bands are not the official position of the Band Councils.

- Want to be on study planning committee.
- Twenty-five years ago the problem of eroding river banks was brought to the attention of government and Ontario Hydro but nothing was done.
- When logging booms were in place years ago, the erosion was less.
- The river channel has changed a lot over the years and a lot of land has been lost.
- The major thing to help the fisheries would be to reduce turbidity, but that there is no way the fishery can be fully restored. Water fluctuations should be such that the water quality is protected.
- Concerned not only with speckled trout but whitefish, sturgeon, etc., as well.
- Lack of close consultation was demonstrated by fact that they were not notified of recent pipeline work.

Shore Property Owners/ Tourism Operators/ Boating - Polly Lake/ Lake Helen

Polly Lake

- For some cottages ('camps'), changing water levels can vary their beach up to 150'.
- To account for both high and low water levels, boat docks have to be placed inconveniently far out into the lake, making it a long walk back to the shore.
- On the south side of Polly Lake when the water is low, it is too dangerous for children to swim as the lake bed drops off suddenly.
- Low water levels leaves a deep beach area which some cottagers abuse by driving four-wheelers.
- When the water recedes it leaves behind decomposing plant life which smells bad enough that prevents resident use of the lakefront.
- Higher water levels have required many residents to construct retaining walls - some have had to build three or more walls.

*Please note that these comments are the **opinions and viewpoints** of the various individual stakeholders at the time of the interviews.*

- Some have lost their boat houses because they didn't have wall or it wasn't high enough.
- Cottagers observe fish populations have dropped, particularly since the 60s - they wonder if it is because their 'hiding places' are gone - there is nothing predictable about where they'll be (there are no more lily pads apparently, weed beds cannot survive the fluctuations).
- Fluctuations affect the temperature of the lake - its hard for it to warm up the way it used to because of the new cold water which comes in - it can drop 20 degrees in a weekend which cottagers feel is hard on the bait fish.
- Raising and lowering the levels allows plant life to rot - in winter residents cut holes in the ice to take water but find its not drinkable and smells of rotting weeds, etc..
- Higher levels wash trees and bush into the water making for navigational hazards.
- There was once a tourist lodge on Polly Lake but levels made it impossible to run.
- Most would prefer it to be two feet lower than it is now.
- Their recommendation: that a berm be put at the inlet where Polly Lake meets Lake Helen - some sort of control mechanism.
- Polly Lake - from the "lowest" level, the water could rise 3' resulting in no beach but also no erosion damage. A 2' range is preferable. In 1992 the water level was good and even - could have been 1' higher during June, July and half of August. If Hydro had let more water go in June, July and half of August, then major flooding in September would not have occurred.
- See Photographs 3.3.1a and 3.3.1b - Flooding of shore property, Polly Lake, September, 1992. (shore wall is 2.5' high above beach and at "low" water level the sand beach is 75' wide)

Lake Helen

- Commercial campground operation is the main activity on Lake Helen other than Red Rock Band.
- Fishing is unaffected - patrons keep coming back.
- High water takes away his picnic areas and beach.
- Mooring boats is a problem - patrons wake up and find their boat is aground.

*Please note that these comments are the **opinions and viewpoints** of the various individual stakeholders at the time of the interviews.*

- Has a wall close to shore and has had to reinforce the cribbing again and again.

Public Works Department - Nipigon

- If water is too low it is very silty and requires 'backwashing', and has to add more chlorine.
- Water fluctuations make banks unstable so that when it runs high again the banks fall in.
- Public is not really concerned about this here.

Public Works Department - Red Rock

- Does not affect intake because their pipe is half mile out.
- Some changes in the waterfront - the sand bars are gone.
- Debris clearing is an issue.

Lake Nipigon

General

- Lake Nipigon is the "sixth" Great Lake. You can drink the water directly from the Lake. It is a beautiful, unspoiled wilderness area that should be treated with more respect. All were concerned with the long term sustainability of the Lake and its resources.
- The water level this year (1992) is very high.
- The upper limit of Hydro's absolute range was authorized by MNR in 1974 to be increased from 260 m (853') to 260.6 m (855'). Some claim that the increase was supposed to be contingent on clearing of the shoreline which was not done.
- Wind set-up, due to a storm, can raise the still water level. Estimates of wind set-up were of the order of 15 cm (6") to 30 cm (1.0'). In some bays, estimates were as high as 0.6 m (2') or more.
- The water level gauges should not be controlled by Hydro but by an "independent" group. The water level should not be taken as the average of the two gauges on opposite sides of the Lake. The level recorded at any one gauge is the level they see in that area, not the average of the two.

*Please note that these comments are the **opinions and viewpoints** of the various individual stakeholders at the time of the interviews.*

- Many people want the lake levels to be maintained between 259.4 m (851') and 260.0 m (853'). Others felt an upper limit of 260.3 m (854') would be acceptable. Others felt the range should be limited to about one-half to two-thirds of the present range. Another opinion called for the range to be 259.1 m (850') to 259.7 m (852'). There are some who want the dams removed entirely. Another view was that the water level fluctuations were acceptable.

- Lake Nipigon should not be used as an energy reservoir for the Niagara generating plants at the expense of the health of Lake Nipigon. There were some who said the Ogoki diversion should be turned off permanently.

- When logs were run up the early 1970's, Lake Nipigon levels were held more constant by Hydro.

- Some felt that Hydro could not control the natural fluctuations of the Lake. Others are convinced that the natural fluctuations would be less severe than the fluctuations "caused" by Hydro.

- One lake user stated that each 0.3 m (1') of reduction in Lake level cost Hydro $5 million in lost revenue.

- One person observed that just a few days prior to September 6, 1992, water was still be diverted from the Ogoki down the Little Jackfish River even though he was sure that the level of Lake Nipigon was above 260.45 m (854.5').

- Repeated perception that 'a computer in Toronto makes all the decisions'.

Lake Fisheries

- Reduced fish stocks were blamed, in part, on fluctuating water levels - too high through the summer and too low in the spring, after the draw-down period (September to after ice-out).

- MNR is wasting time with the brook trout in the lower River and the Bay when they have the "best" fishery in the Lake and they are not doing anything about it. Pollution, too many salmon and overfishing along with the fluctuating levels are to blame for the loss of brook trout below dams.

- High lake levels cause flooding and erosion of the shoreline. The vegetation and trees around the shoreline are submerged. The decaying organic matter releases methyl mercury into the water. The methyl mercury contaminates the fish. The erosion of the shoreline banks causes sediment to be introduced into the water. Increased sediments results in siltation of the spawning beds.

*Please note that these comments are the **opinions and viewpoints** of the various individual stakeholders at the time of the interviews.*

- In 1988 highly silted water in McIntyre Bay resulted in the brook trout not spawning.
- Low lake levels expose fish spawning beds causing increased egg mortality, reduced nursery habitat and access to rivers/streams for cover. When the lake is drawn down to its low level, there is increased ice scour of the shoreline including spawning areas.
- Spawning beds for speckled trout are adversely affected when water levels drop and leave spawn exposed.
- It was suggested by some that overfishing, large-scale spawn-taking by MNR, the presence of smelt and previous logging operations were also to blame for decreased fish stocks. Some stated that MNR's historical taking of trout brood stock was more to blame for declining fishery than fluctuating water levels but that maintaining a minimum level of water over the spawning beds is the required solution.
- Many are convinced that sediment from the Ogoki diversion is covering spawning areas (both within Ombabika Bay and out into the Lake). Others do not share this view.
- More efforts and resources should be committed by MNR to preserving and enhancing the fisheries in Lake Nipigon - not all the money should be spent on the Nipigon River and Nipigon Bay.
- Some commercial fishing people claim that fishing is good or has never been better for whitefish, pickerel and lake trout. Another comment was that there was "no problems with speckled trout". Others disagreed and claimed that speckled trout fishing was down - that is why MNR reduced the limit on speckled trout.
- Low waters were seen by the commercial fishing people to be the bigger problem as it limits access to river mouths. Higher levels do affect docks.
- Some felt that closed seasons, quotas and, recently, better enforcement have helped to improve the fishing. Some expressed that, in the past, MNR had not done a good job in managing the fisheries.
- Quotas are not necessarily representative of the health of the fisheries. Quotas were based on past performance and not supply of fish.
- Exposing spawning beds will have an effect in the long-term.
- Some commercial operators are saying that whole year classes of fish are gone.
- Some operators would like the level to stay at 853' - a two feet fluctuation would be tolerable.

*Please note that these comments are the **opinions and viewpoints** of the various individual stakeholders at the time of the interviews.*

- Anglers fish for speckled trout (release catch due to declining populations), lake trout, pike and pickerel.

- If recreational fishing declines, tourism declines - all suffer.

- Charter operator relies on the speckled trout fishery for business. Do not know what they would do to replace lost income if fishery closed down.

- Some anglers reported that the lake needs to be stabilized with a maximum lake level dropped and the operating range narrowed.

First Nations/ Traditional Lifestyles

Note: Comments provided by individuals of the various First Nation Bands are not the official position of the Band Councils.

- Placement of the dams has flooded aboriginal hunting and fishing areas, offering rocks, burial grounds, areas where medicinal plants are harvested. Loss of traditional access has eroded pride, dignity, self-respect, respect for government.

- Remove the dams.

- Elder says water level is near, or as high, as ever.

- Shoreline being eroded (see Photographs 3.3.2) and breakwater (see Photograph 3.3.3) and dock damaged during storms at high water.

- Must work hand-in-hand with others, including Hydro, to keep the lake beautiful.

- Some believe Ontario Hydro exercises significant control over Lake Nipigon levels.

- Bands have past grievances re: erosion, fluctuating levels. Outstanding complaints since after World War II.

- Due to high levels, Whitesand Band had to move to Armstrong. Sand Point Band also displaced.

- High levels affected people the most.

*Please note that these comments are the **opinions and viewpoints** of the various individual stakeholders at the time of the interviews.*

- High water: covers shoals; erodes the shoreline; covers over beaches; forces beaver to move inland; and causes fish to move off their old spawning beds and closer to the new shoreline with their spawning beds then exposed when the level goes down. The deeper the water, the calmer the water; the calmer the water the less likely some species of fish (like sturgeon) are to spawn.

- 1991 was a "normal year" and 1989/90 was a good year (there was no damage done). Five years ago the water was low and it also was a "good year". The lake level should be dropped at least 1 foot and maybe 1 1/2 feet.

- The dock on Gull River had been ruined because of high water levels - the dock was under water at first and then was lifted off its posts. Hydro should compensate for damages.

- 200 feet of shoreline had been lost because of high water levels and Ontario Hydro is deliberately trying to destroy the fishery by raising and lowering the lake level.

- It is time to stop talking and time to take action.

- Why was the Band not asked to bid on this project? The people most affected were again left out, that they are always excluded from developing resource management strategies. The Band's opinion is always ignored.

- This meeting would allow MNR to claim that the Band had been consulted - and that the study team was not even talking to some of the important people of the Band.

<u>Shore Property Owners/ Tourism/ Boating</u>

- High levels reduce the natural beauty of the shoreline.

- High levels submerge the swimming beach near Beardmore (see Photographs 3.3.4a and 3.3.4b). High levels have eliminated the beach at the mouth of the Sturgeon River.

- Storms at high levels cause erosion of shoreline properties and damage to protective structures (see Photograph 3.3.5) and docks (i.e., at Poplar Point, Macdiarmid, see Photographs 3.3.7a, b and c).

- High levels require the installation of erosion protection works.

- High levels are the bigger concern - most affected in the summer.

*Please note that these comments are the **opinions and viewpoints** of the various individual stakeholders at the time of the interviews.*

- One cottager stated that in 15 years, low levels have never been a problem. The ideal level is at ice-out time in May.

- Transfer of ownership of shoreline frontage from MNR to private individuals done during a period of lower water levels. Subsequently the water levels have returned back to average and higher than average.

- Some have lost significant amounts of shoreline/lakefront.

- The future of the area depends on maintaining the natural features for tourism.

- Decreases in the numbers of fish reduces the tourist interest in charters.

- A high lake level:

  - reduces beachcombing opportunities for tourists because of flooded shorelines;
  - hides rocks and other obstacles from view making navigation more hazardous;
  - causes erosion of shoreline resulting in floating logs and debris which are hazardous to boaters; and
  - causes damage to docking facilities.

- A low lake level:

  - reduces draft resulting in decreased accessibility to docks, creek mouths for fishing; and
  - increases difficulty and cost of launching boat in spring.
  - some navigational hazards with exposed rocks.

- Storing boats in winter a problem because spring levels in the channel are low to get boats on to the Lake - delays their tourist season by as much as three weeks.

- Over the years this has cost one operator $20,000 plus the inconvenience of having to haul his tools and materials to the storage site every day in order to work on his boat.

- Higher levels cause erosion which creates a silt buildup and makes the channels more shallow - can't take tourists in to the places they used to because they run aground.

- Higher water takes away beaches so tourists can't swim and hunters have no where to stand.

- Some concern that Lake Nipigon is one of the last 'pristine' inland Lakes and it should be preserved.

- Fluctuations have meant replacing docks that have been damaged.

*Please note that these comments are the **opinions and viewpoints** of the various individual stakeholders at the time of the interviews.*

Ontario Hydro

- Ontario Hydro does not control the total amount of water - they only manage the flows and levels for hydro-electric power generation - Ontario Hydro flattens out the natural peaks and lows.

- Sympathy for those affected, especially the natives who were there before the dams.

- "original" flow restrictions for spring spawners (i.e., increase minimum from 70 m^3/s to 113 m^3/s) were not major difficulty for Hydro's operation.

- Subsequent complaints from stakeholders on the Nipigon River resulted in a minimum flow of 170 m^3/s throughout the summer.

- Earlier fluctuations were "soft". For example, in the past, peaking was more likely to be on a weekly basis (i.e., increase flows and leave higher for the whole week, Monday through Friday, and then decrease flows and leave low for the weekend). During the 1986-87 drought, it was necessary to peak from 170 m^3/s to 400 m^3/s twice a day to get the most value from the minimal amount of water available. This would be considered the opposite of "soft" peaking.

- Further restrictions were imposed in response to April 1990 landslide. A subsequent study showed that the fluctuations were not the cause of the landslide, but MNR maintained restrictions for fisheries.

- Ontario Hydro is concerned that minimum flow restrictions as they are now, hinder their ability to deal with natural variations as well as generation contingencies.

- Concerned that the lake may reach a marginal flood situation because of unusually high inflows combined with flow reductions for pipeline construction and lampricide application.

- Ontario Hydro wants some flexibility in their operation.

- Their mandate is to provide reliable efficient energy so that their management technique is to use the lake primarily as an energy reservoir with consideration to the environmental and social impacts. To change totally and make the primary focus the environment and social with energy generation as only a secondary consideration would be "economic suicide" for hydro-electric generation in the province.

- Ontario Hydro wants to find "the best middle ground" .

3.4 EPILOGUE

The study team found a prevalent feeling among a good number of the stakeholders that the natural beauty, the fisheries and the water quality of Nipigon watershed are precious resources that had to be respected and protected. There was a strong recognition that to sustain the Nipigon for future generations required a change in how the resources of the watershed, including water level and flow fluctuations, were managed. A previous study reported that a core group of individuals in the community understands that historically "local industry and human occupation have changed the environment of Lake Nipigon and the Nipigon River. There is also a realization that as the northernmost feeder lake into the Great Lakes system, Lake Nipigon's pure waters are an important part of the system" (Marshall Macklin Monaghan, 1991).

While there is a common feeling amongst many of the stakeholders that improved management of the Nipigon watershed system is desirable, they differ in their understanding of the system, in their views on what are the most serious stresses on the environment, and in their preferred courses of action. The interests of the stakeholders at times conflict and at other times coincide. In Chapter 4, the issues and conflicts are discussed.

Photo 3.3.1a & 1b Flooding of shore property, Polly Lake (September 1992)

Photo 3.3.2 Shoreline erosion at Rocky Bay First Nation Reserve (August 28, 1992)

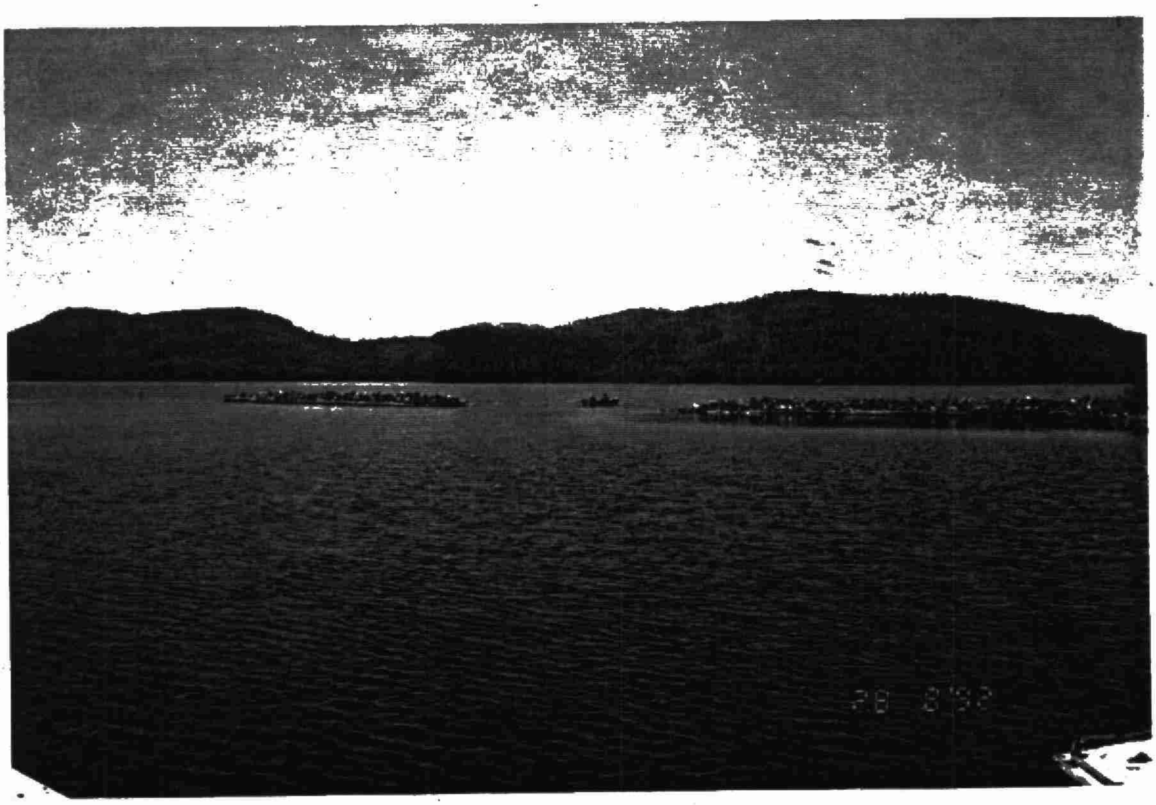


Photo 3.3.3 Damaged breakwater at Rocky Bay First Nation Reserve (August 28, 1992)

Photo 3.3.4a & 4b Narrow beach at Poplar Point, Lake Nipigon (August 27, 1992)

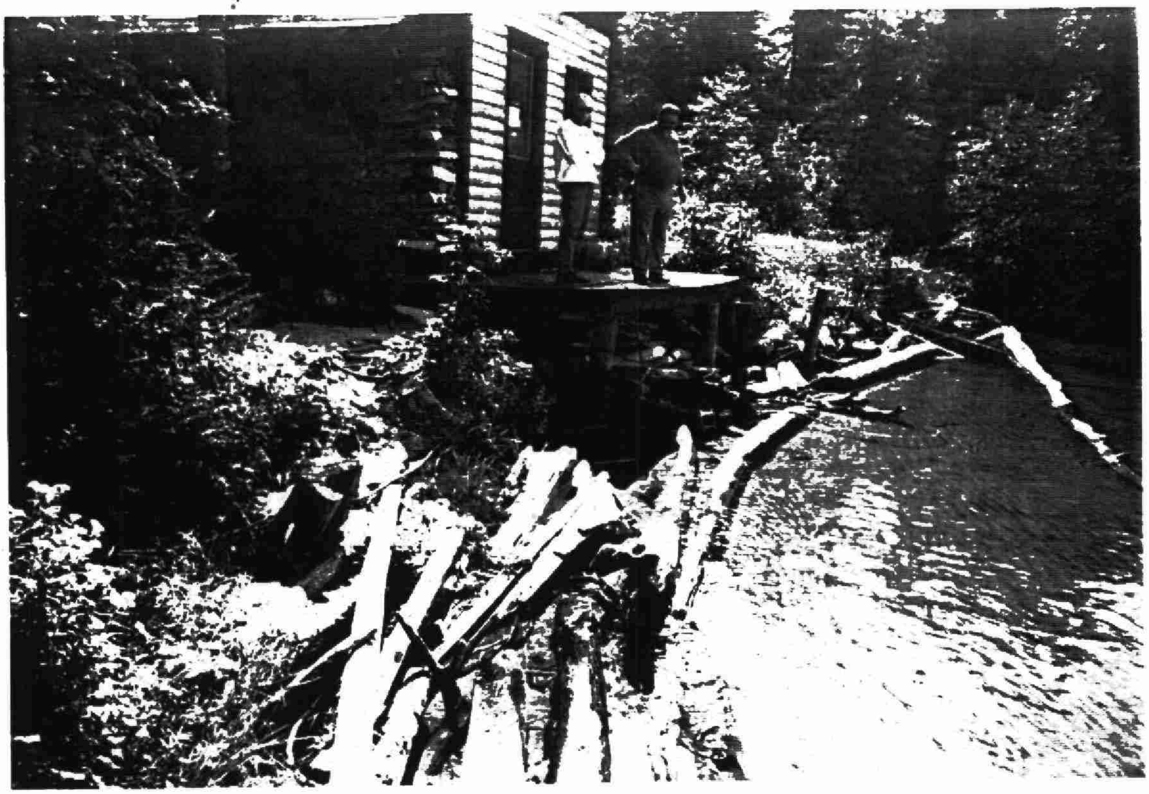


Photo 3.3.5 Shore property erosion, Lake Nipigon (August 27, 1992)

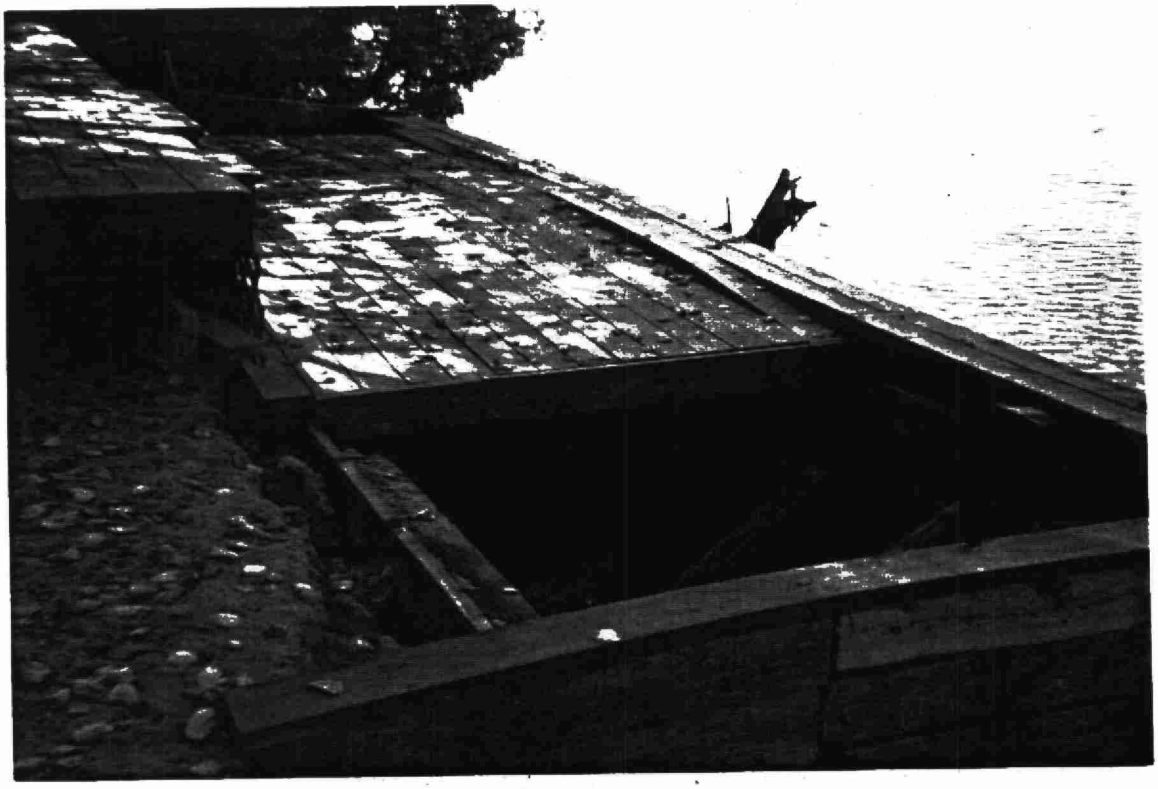
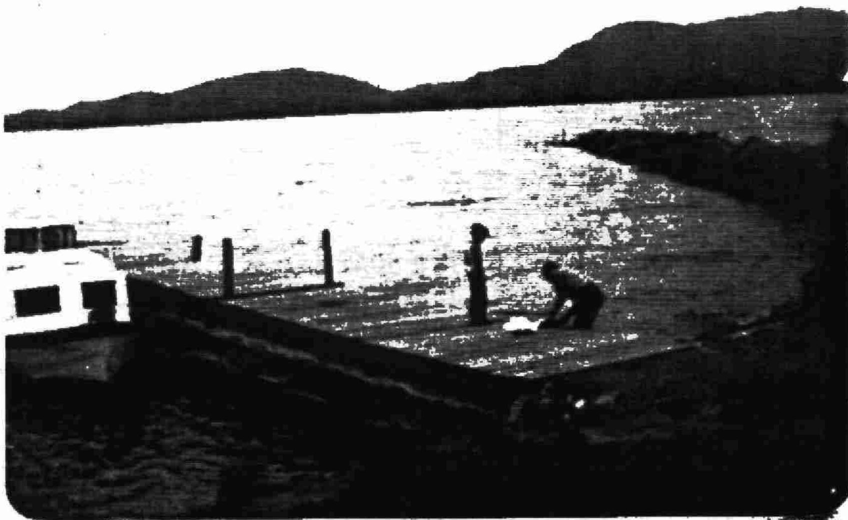


Photo 3.3.6 Shore structure damage, Lake Nipigon (1992)

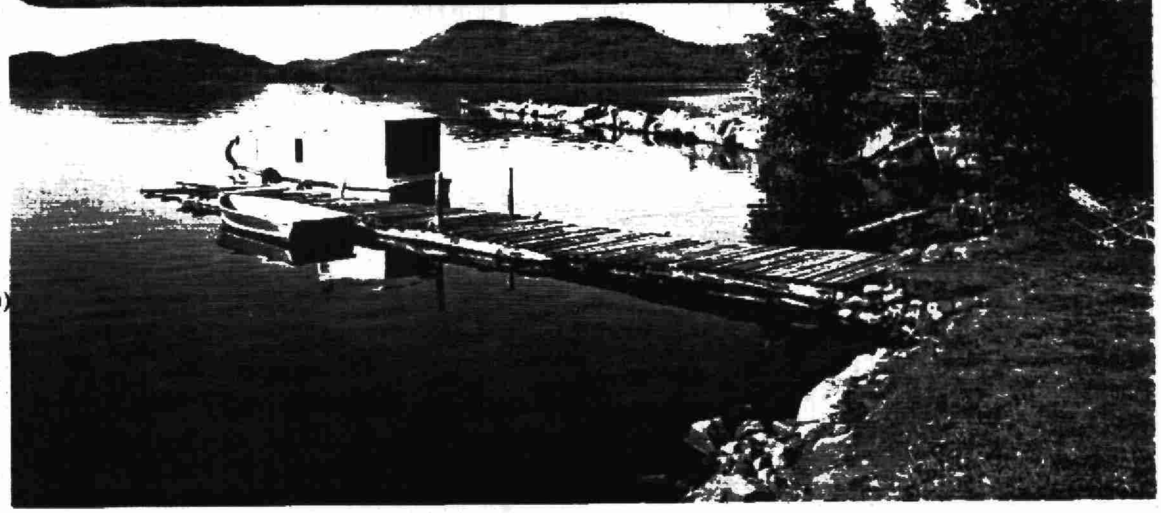
7a

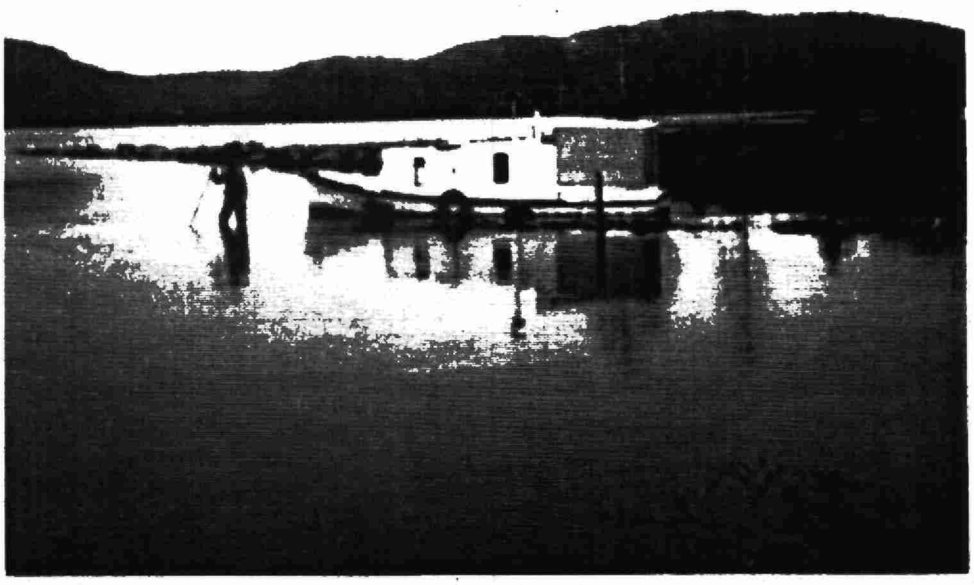
August 1980 (recorded water level ±259.6 m)



7b

August 28, 1992 (recorded water level 260.3 m (854'))





7c

October 1992 (recorded water level 260.44 m to 260.72 m)

Photo 3.3.7 Boat dock at Macdiarmid, Lake Nipigon

4.0 ISSUES AND CONFLICTS

4.1 INTRINSIC AND RESOURCE VALUE

One view is that the features of the Nipigon, such as clean, flowing water, the fish and the scenery, have intrinsic value. The very fact that these aspects of the Nipigon exist merits their protection. There is no monetary value involved. This view is expressed in statements such as:

> "What's the value of a loss of a species [in reference to speckled trout]."

A conflicting view is that the natural resources of the Nipigon, such as hydro-electric potential, commercial fishing capacity and tourist attractions, should be utilized to the maximum benefit of people, both locally and beyond. A dollar value is assigned to the resources and the fiscal benefits and costs are counted.

It appears to the study team that for the most part the stakeholders hold a view that is somewhere in between these two extremes. There seems to be a consensus by most of the stakeholders that the intrinsic features and the natural resources of the Nipigon are one and the same. Many of those people with little or no monetary interest in the Nipigon watershed (i.e., those who do not earn a livelihood from it) understand the needs of those who do, but at the same time they insist that those who utilize the resources must do so in an environmentally sound manner. There is a growing realization by those who utilize the resources that they must do so in an environmentally sustainable way to ensure future prosperity.

The conflicts generally arise when assessing the magnitude of the impacts of various activities and when determining the relative contribution of the various activities to impairment of the environment. At times, the lack of a clear understanding of the actual physical and biological processes and the lack of sufficient data can increase the conflicts.

4.2 HYDRO-ELECTRIC DEVELOPMENT

The Nipigon hydro-electric system has helped meet the energy demands of the northwest region and the rest of the province of Ontario (see Appendix 2A.1 for some further information). The Nipigon system reduces the need for generation from other sources such as thermal (i.e., coal) and nuclear plants and/or the purchases from other outside utilities. Hydro-electric generation is clean and utilizes a renewable resource. Coal fired plants increase acid gas emissions.

Along with the benefits that the Nipigon hydro-electric system provided for the development of the region, come the environmental "costs". Construction and operation of hydro-electric dams have resulted in significant physical alterations of the Nipigon River system. Extensive flooding has occurred upstream from the dams and aquatic habitats are no longer accessible to Nipigon River fish populations. It has been reported that most of the prime brook trout habitat occurred upstream from Alexander Falls (RAP, 1991). In addition, there has been ancillary development associated

with the hydro-electric stations including construction of railway lines, bridges, access roads, townsites (Pine Portage and Cameron Falls), transmission lines, temporary coffer dams, diversion channels and power houses.

Hydro-electric development has contributed to the decline of native fish populations in the Nipigon River and continues to have an impact on the aquatic community. The fisheries are discussed in Section 4.5.

4.3 ONTARIO HYDRO OPERATING PROCEDURES

4.3.1 General Procedures

Introduction

To regulate a watershed such as the Nipigon, within prescribed limits, it is necessary to anticipate future inflows. If we were able to know, far enough ahead of time, what the inflows would be, regulating the level of the lake through controlled river discharges would be relatively simple. However, we are not able to get good advance knowledge of the inflows.

Primarily, the inflow into Lake Nipigon is from the precipitation that generates runoff and the Ogoki diversion. While we are able to control the Ogoki Diversion, long range forecasts of precipitation are unreliable. Also, the amount of precipitation that is lost to evapotranspiration and infiltration, before it reaches the lake, is highly variable. As a result, it is not possible to have good advance knowledge of the inflows.

An inflow forecast can be prepared based on the range of inflows which have occurred in the past, and the antecedent basin conditions. Given this information (i.e., the most likely inflow, using historical data), along with a knowledge of the effect of different outflows on the downstream river levels, an appropriate outflow can be selected. As time goes by, the outflow is adjusted to compensate for the actual inflows which may be larger or smaller than originally forecast. The process involved does not involve any sophisticated hydrologic or hydraulic models. It depends on a basic understanding of the hydrologic response of the Nipigon watershed and the experience of those involved.

Ontario Hydro' Procedure

An effective operation of the Nipigon system requires understanding of the hydrologic and hydraulic characteristics of the drainage basin. As mentioned in Section 2.1, Lake Nipigon is operated as an annual reservoir system (i.e., under normal operating conditions, the reservoir requires slightly more than one year to fill up and slightly more than one year to empty). Ontario Hydro's general principal for operating the power generating stations includes;

i) storing as much as possible of the spring freshet from April to May,
ii) holding water back through the summer, from June to September, for power generation in

the winter, and

iii) dropping the lake level uniformly in fall and winter, from October to March, so that at its lowest point the spring freshet starts again.

Ontario Hydro's procedure for forecasting the lake level and river outflow generally follows the points outlined previously in this section. The Operations Planning Department of Ontario Hydro prepares a utilization guideline plan every year for Lake Nipigon. The plan is prepared before winter and is used to schedule the operation of the power generation stations for a 12 month period from October to September. The utilization plan generally includes a drawdown procedure for the water level of Lake Nipigon before the spring freshet and guidelines for the extent of outflows, the maximum flow reduction and the peaking restriction (R. Vinski, Ontario Hydro, 1993, pers. comm.).

The procedure to prepare the utilization plan is as follows:

1) First, a target elevation of Lake Nipigon before the freshet begins the following spring is selected. The target elevation is normally set about 259.5 m (851.4') and is adjusted depending on the inflow conditions and the current water level at Lake Nipigon.

2) The required outflows from the generation stations are then determined using a computer program, called RISK, to bring the level of Lake Nipigon to the target elevation prior to freshet. The computer model RISK was developed by Ontario Hydro and is also used for other Ontario Hydro plants. RISK is a simulation model written in FORTRAN and it accounts for flow continuity. Historical basin inflows are input into the model, the water levels at Lake Nipigon are simulated with the scheduled outflows and the exceedance probability of the water level greater than the target elevation will be computed. The scheduled outflows will then be adjusted if the risk is too high.

3) For example, if the current year is a dry year and the Lake Nipigon water level is low, the probability of the water level being less than the target elevation will be high. The outflows could be adjusted or the target elevation could be set lower, e.g. 259.4 m (851.1'). Normally, the target elevation would be set above the minimum operating limit (259.3 m) to provide some remaining storage for power system contingencies.

The utilization plan is monitored throughout the operation period and could be revised every week.

As an example, Ontario Hydro's Lake Nipigon Utilization Guideline for 1991/1992 is presented in Appendix 4A.

Since the system is an annual reservoir system, its performance is very sensitive to the precipitation inputs. If the previous year is a dry year (i.e., the snowfall amount and freshet volume are below normal), the minimum operating limit of Lake Nipigon will be watched very closely during the drawdown period. In this case, minimum water will be discharged downstream to ensure sufficient volume of water in the lake to be above the minimum lake elevation. On the other hand, if the current year is a wet year, greater amounts of water will be discharged in order to maintain the lake water level below the maximum operating limit. Therefore, the wider the operating range on the lake is, the more flexible the operating procedure will be, and the flow in Nipigon River will be

more stable, or constant. A narrower range of water levels on the lake results in a greater variance in the river flows as Hydro attempts to adjust more quickly to the inflows into the lake.

The study team interprets that, prior to the 1990's, Hydro's objective for their forecasting procedure was to regulate the lake level between legally specified upper and lower bounds and maintain the average river flows between minimum and maximum values. Based on the recorded data from 1951 (construction of Pine Portage GS) until 1990 (prior to the present additional river flow restrictions, as discussed in Section 4.3.4), as seen in Appendix 2A, Hydro's procedure has been effective in meeting Hydro's objective. However, the procedure will require additional considerations to address the fisheries concerns (see Sections 2.2 ad 4.5) and the competing interests of the other stakeholders (see Chapter 2, Section 2.3).

Ontario Hydro's Directives

Ontario Hydro's Technical Directives (HO 853, issued August 1983; HO 851 and HO 850-R1, issued October 1983; HO 849-R1 and HO 852-R1, issued June 1985) provide the following notes which governed their operation of the Nipigon system.

- Lake Nipigon and the Ogoki Diversion are regulated according to the "Nipigon - Ogoki Regulation Study" dated July 1962, which superseded a similar study dated January 1, 1952. Normally, the Summit Control Dam remains open year round diverting water from the Ogoki to Lake Nipigon. The flow into Lake Nipigon from the Ogoki Reservoir must not exceed 113 m^3/s when Lake Nipigon is above 260.3 m (854.0') and when Lake Nipigon is above 260.45 m (854.5'), the diversion flow must be reduced to zero.

- Lake Nipigon

- operating range	1.0 m from 259.3 m to 260.3 m (850.8' to 854.0')
- flood allowance	0.3 m above 260.3 m, increased to 260.6 m (854.0' to 855.0')
- energy emergency	0.2 m below 259.3 m, decreased to 259.1 m (850.8' to 850.1')
- absolute range	1.5 m from 259.1 m to 260.6 m (850.1' to 855.0')

- Jessie Lake (forebay storage for Cameron Falls GS)

- operating range	0.6 m from 226.8 m to 227.4 m
- flood allowance	0.13 m above 227.4 m, increased to 227.53 m
- energy emergency	1.86 m below 226.8 m, decreased to 224.94 m
- absolute range	2.59 m from 224.94 m to 227.53 m

4.3.2 Peaking

Peaking is an operating procedure used by Ontario Hydro to generate electricity to meet the daily demand pattern. The pattern is that there is generally more demand ("on-peak") for electricity during

the day and in the evening, and less demand ("off-peak") through the night. Normally, for the Nipigon system, a peaking pattern comprises of a 16 hour on-peak cycle (starting at 7 am, ending at midnight) of increased flow (to generate more electricity), followed by an 8 hour off-peak cycle (starting at midnight, ending at 7 am) of decreased flow. For example, when the average daily discharge is 350 m^3/s for 24 hours, the generating stations can potentially operate at 440 m^3/s on-peak for 16 hours and 170 m^3/s off-peak for 8 hours. The combined volume of water that results from a flow of 440 m^3/s for 16 hours and a flow of 170 m^3/s for 8 hours is the same as the volume of water from a flow of 350 m^3/s for 24 hours.

The biggest peaking operation in Nipigon involves increasing and decreasing the discharges at all three generating stations at the same time.

Peaking becomes more effective under low flow condition rather than high flow condition. In fact, peaking is not possible under high flow conditions as the generating stations would already be operating at full capacity.

The peaking operation is designed to meet with the high demand in a day. A reduction of peaking capacity would be considered as a loss to Ontario Hydro. They would be unable to produce additional electricity to sell during the period of high demand when users are willing to pay more. The value of peaking in hydro-electric generation depends on the marginal costs. The term incremental cost and marginal cost refer to essentially the same concept. The word increment means increase, and an incremental cost means an increase in cost. Usually, reference is made to an increase of cost in relation to some other factor, thus resulting in such expressions as increment cost per tonne, increment cost per litre, or increment cost per unit of production. The term marginal cost refers specifically to an increment of output whose cost is barely covered by the return derived from it (Fabrycky and Thuesen, 1974).

The marginal cost can be considered Ontario Hydro's corporate energy cost or the cost of power that could have been produced by the Nipigon stations (B. Lomenda, Ontario Hydro, 1993, pers. comm.).

Table 4.3.1 shows a monthly system marginal costs forecast for 1993 (R. Vinski, Ontario Hydro, 1993, pers. comm.). From Table 4.3.1, it can be seen that "value" of the energy produced by the Nipigon system varies depending on the demand. The demand varies by month, by day of the week (weekday, Saturday, and Sunday or holiday) and by time of day (on-peak or off-peak). The greatest demand (highest marginal cost) is during the day (on-peak) on weekdays in the winter. The lowest demand (lowest marginal cost) is during the night (off-peak) on Sundays and holidays during late spring.

Use of other more expensive generation such as thermal (coal), nuclear and/or purchases from other utilities to maintain operating capacity and reserve is possible, but using as much hydro-electric generation as possible, during periods of high demand for electricity (on-peak), reduces the overall fuel costs for Ontario Hydro.

Restrictions, such as minimum instantaneous flow rate required for fish spawning, can limit the amount of peaking that has occurred in the past or that is possible. Restrictions are discussed in the

(R. Vinski, Ontario Hydro, 1993, pers. comm.)

1993 FORECAST OF SYSTEM MARGINAL COSTS
($/Mwh)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
MONTHLY COMPOSITE	19.8	21.5	20.4	14.2	12.3	12.4	12.9	16.8	15.0	14.2	16.7	17.1
WEEKDAYS COMPOSITE	21.1	23.0	21.3	15.9	14.9	14.5	15.0	20.1	16.8	16.4	17.4	18.0
WEEKDAY ON-PEAK	22.9	25.8	23.2	18.0	18.2	17.8	17.9	23.2	19.7	18.3	18.8	19.0
WEEKDAY OFF-PEAK	17.6	17.5	17.6	11.7	8.3	8.0	9.4	13.8	10.9	12.6	14.7	16.1
WEEKEND COMPOSITE	17.5	17.7	17.8	10.1	7.5	6.4	8.5	9.9	10.9	10.2	14.6	15.1
SATURDAY ON-PEAK	18.8	18.3	18.8	13.7	7.4	6.4	9.4	12.8	17.1	13.6	18.2	15.7
SATURDAY OFF-PEAK	17.1	16.8	17.1	7.0	6.4	6.4	7.9	11.3	7.3	9.4	13.0	14.2
SUNDAY & HOLIDAYS ON-PEAK	18.3	17.6	18.2	10.2	8.5	6.4	8.5	8.4	9.4	9.3	15.6	15.7
SUNDAY & HOLIDAYS OFF-PEAK	14.2	17.5	15.3	6.7	6.8	6.4	7.0	8.0	6.7	7.0	6.7	13.6

Notes:

1. On-Peak is defined as hours 8 to 23.
   Off-Peak is defined as hours 1 to 7 and 24.
2. The marginal costs are based on traditional running costs and may be used for evaluating the cost and timing of events (ie. outages). Significant large events may require additional analysis.
3. These costs will be reviewed on a monthly basis and updated as required.

Table 4.3.1 1993 Forecast of system marginal costs

next two sections.

4.3.3 Restrictions

Ontario Hydro's Technical Directives (HO 849-R1, HO 850-R1, HO 851, HO 852-R1 and HO 853) also provide the following environmental and social restrictions which governed their operation of the Nipigon system.

- Lake Nipigon elevations below 259.1 m (850.1') cause difficulties for commercial fishermen and tourist camp operators.
- Shoreline erosion damage occurs at various locations around Lake Nipigon when the elevation exceeds 260.15 m (853.5') for long periods of time.
- The minimum average daily discharge at Alexander GS is 170 m^3/s during the summer months, from May through September, with 113 m^3/s being the minimum at all other times to provide an adequate level for the Town of Nipigon water intake (F. Benzaquen, Ontario Hydro, 1990, pers. comm.). The hourly minimum discharge is 70 m^3/s providing the daily average can be satisfied. One Alexander GS generating unit running at efficiency is 70 m^3/s.
- The maximum allowable Lake Nipigon outflow at Pine Portage GS is 566 m^3/s. This value is set so that the flow out of Lake Helen, at the CPR bridge in Nipigon, is less than 623 m^3/s. This flow restriction is to protect the footings of the CPR bridge (F. Benzaquen, Ontario Hydro, 1990, pers. comm.)
- Cameron Falls GS is only a short distance upstream from Alexander GS, and because there is very little storage capacity between the plants, it is necessary that changes in flow at Cameron Falls be quickly followed by similar changes at Alexander GS.

4.3.4 Additional Restrictions

In 1981, the minimum discharge from Pine Portage GS was lowered to 113 m^3/s from a previous rate of 170 m^3/s (Ritchie and Black, 1988).

In the early 1980's, the operating range of Lake Nipigon was reduced by 0.2 m (R. Penn, Ontario Hydro, pers. comm., 1993).

An earlier "voluntary" restriction limited the minimum flow to 170 m^3/s due to erosion of clay banks on Lake Helen.

There is now an interim agreement between Nipigon MNR and Ontario Hydro (originally announced October 15, 1990) that has altered Hydro's operating procedures on the Nipigon River. The purpose of the agreement, which started in 1991, is to increase protection of the brook trout spawning sites, on the Nipigon River, from exposure by supplying enough flow to cover the sites

during development of the young fish (OMNR files, cited in Wilson, 1991; Ontario Hydro Information release, October 15, 1990; Q. Day, MNR Nipigon District, January 8, 1991 letter). Since it was first announced, the agreement has been renewed and has changed. At the present, the agreement is such that Ontario Hydro will maintain a minimum instantaneous flow of 260 m^3/s at Alexander GS from October through to May 15 (fall spawning, winter incubation and spring hatching) (R. Swainson, MNR, 1993, pers. comm.; B. Lomenda, Ontario Hydro, 1993, pers. comm.). The previously used minimum flow of 170 m^3/s (R. Penn, Ontario Hydro, 1993, pers. comm.) would be maintained from May 15 through to the end of September. It should be noted that this is a voluntary arrangement between Ontario Hydro and Nipigon MNR and is not legally binding. However, it is the view of some that failure to follow this agreement will result in the destruction of fish habitat which is illegal under the Fisheries Act.

In May 1991, in response to the April 1990 landslide, a peaking restriction downstream of Alexander GS was put into place. There is no restriction on increases but the flow reduction is limited as follows (Ontario Hydro Utilization Guideline H700-R2, Nov. 28/92):

- The maximum flow reduction over a 24 hour period is 100 m^3/s.
- The flow reduction must be done in stages. The maximum reduction in a single event is 50 m^3/s.
- A minimum 4 hours must pass between flow reductions.
- The 24 hour period begins with the first flow reduction.

In October 1991, MNR confirmed the continuation of the operating restrictions due to their concerns with respect to the effects of the fluctuating levels on the fisheries.

In 1993, Ontario Hydro adopted a different restriction on the peaking decrease. Any magnitude of decrease can occur, within the identified flow restrictions, as long as it occurs over a 24 hour period in equal hourly steps for flow reductions greater than 50 m^3/s (B. Lomenda, Ontario Hydro, 1993, pers. comm.)

4.3.5 Value of Hydro-electric Power

A statistical summary of the historical monthly net energy productions for the three Nipigon stations (from January 1960 to December 1991) were provided by Ontario Hydro (R. Vinski, Ontario Hydro, 1993, pers. comm.) Using the median values for each month and each station, along with the 1993 estimate of the monthly composite marginal costs, from Table 4.3.1, the value of energy produced during a median year for the Nipigon system was estimated to be approximately \$27.3 million. The calculations are shown in the top part of Table 4.3.2.

Ontario Hydro will incur additional costs, or a "loss of revenue" if the Nipigon stations are unable to generate enough electricity to meet the peak demand. It should be pointed out that while it is called an additional cost for Hydro, in essence it really is an increase in power costs for all the

A. Estimated Median Value of Energy Production

	Net Median Energy Production (MWh) 1000'S				1993	
	Pine	Cameron	Alex.	Total	cost $/MWh	Revenue $
JAN	65.29	44.20	35.13	144.6	19.8	2,863,476
FEB	61.80	43.07	33.53	138.4	21.5	2,975,600
MAR	68.34	46.69	37.12	152.1	20.4	3,103,860
APR	63.97	43.43	32.83	140.2	14.2	1,991,266
MAY	57.21	40.44	31.86	129.5	12.3	1,592,973
JUN	59.58	42.68	32.87	135.1	12.4	1,675,612
JUL	58.81	43.56	32.54	134.9	12.9	1,740,339
AUG	64.94	46.67	36.09	147.7	16.8	2,481,360
SEP	61.97	43.05	33.14	138.2	15.0	2,072,400
OCT	66.42	44.49	35.25	146.2	14.2	2,075,472
NOV	64.61	42.55	34.74	141.9	16.7	2,369,730
DEC	61.78	42.29	33.60	137.7	17.1	2,354,157
Total				1687.		$27,296,240

B. Preliminary Estimate of Replacement Cost Due to Flow Restrictions

Scenario

It is assumed that the daily average flow is 350 m^3/s for the whole year for both cases. Combined, at efficiency, the three Nipigon stations are capable of producing 612 kw for each cubic metre of water per second passing down the river.

- Case No. 1: No restrictions
  For 12 months
  off-peaking 170 cms 8 hours/day
  on-peaking 440 cms 16 hours/day

- Case No. 2: If change to
  Operating at reduced level for 7 months (October-April)
  off-peaking 260 cms 8 hours/day
  on-peaking 395 cms 16 hours/day
  Returning to full peaking for 5 months (May-September)
  off-peaking 170 cms 8 hours/day
  on-peaking 440 cms 16 hours/day

- Assume that loss only due to reduction of power production during the on-peaking period for the 7 months.
  Therefore, energy potentially needed to replace lost peaking energy per day:

  (440-395)=45 cms reduction in flow during on-peak period

  45 cms * 612 kw/cms * 16 hours on-peak/day * 1/1000 = 440.640 MWh

  Energy potentially needed to replace lost peaking energy per year:

  440.640 * 212 days = 93,415 MWh/year

  If the monthly composite cost for the 7 month period is $19.43/MWh then

  cost is 93,415 MWh * $19.43/MWh = $1.8 million

Table 4.3.2 **Estimated values of hydro-electric production**

Hydro users across the province.

In a simplified analysis, a preliminary estimate of the loss of revenue due to restricting the minimum flow to 260 m^3/s, from October to May, is approximately of the order of $1.8 million per year. This simplified analysis is outlined at the bottom of Table 4.3.2.

For the analysis, it was assumed that the daily average flow is 350 m^3/s throughout the year. In Case No. 1, this daily average is comprised of 16 hours of on-peak flow of 440 m^3/s and 8 hours of off-peak flow of 170 m^3/s. In Case No. 2, if this condition is changed to meet the minimum flow requirements for the fisheries, then for 7 months of the year (October through April) the daily flow regime will be 16 hours of on-peak flow of 395 m^3/s and 8 hours of off-peak flow of 260 m^3/s (specified minimum flow for fisheries). For the remaining 5 months of the year, when the minimum flow restriction for fisheries is not applicable, the flows will be the same as in Case No. 1. This restricted flow regime results in the same daily mean of 350 m^3/s.

Further, if it assumed, for the purpose of this exercise, that the loss of revenue, or cost, is deemed to be only the loss of on-peak generation revenue (i.e., not offset by increase in off-peak generation, because it has been assumed that there is no extra demand in the off-peak period), the loss is calculated as the reduced energy production times the marginal cost per MWh (megawatt-hour) for the 7 month period. The marginal cost used for each of the seven months is prorated from the weekday and weekend composites given in Table 4.3.1.

The cost estimate calculated above is only a preliminary estimate. Also, the present flow agreement actually specifies a minimum flow of 260 m^3/s from October until May 15. However, the estimated cost given in Table 4.3.2 shows the magnitude of the loss. The value of production and the potential loss of revenue will be further examined and refined during the second year of the study.

4.4 NATURAL CONDITIONS

The level of Lake Nipigon and the flow in the Nipigon River under natural conditions (i.e., prior to hydro-electric development) would vary subject to the net basin supply. The range of these variations are of interest to this study. There is only about four years of recorded data in the early 1920's, prior to the first dam at Virgin Falls (see Appendix 2A). This length of record is too short to draw any conclusions regarding the long term natural range of lake levels and river flows. Therefore it is necessary to rely on computed estimates of the natural conditions.

Ontario Hydro conducted studies in 1974, 1976, 1979, 1986 and 1990 (Metcalfe, Ontario Hydro, 1990, pers. comm.) to compute the natural monthly water levels at Lake Nipigon and the natural Lake Nipigon discharges (river flows). The computed natural conditions were estimated by a computer model that simulates the monthly inflow, outflow and storage capacity characteristics of Lake Nipigon. The methodology and computation results are presented in Appendix 4A.1. The information includes:

- Lake Nipigon levels
  - observed, from 1921 to 1989

  - computed natural, from 1909 to 1989

- Lake Nipigon discharges (Nipigon River flows)
  - observed, from 1922 to 1989
  - computed natural, from 1909 to 1989.

The plots in Appendix 4A.1 show the estimated effect of the Virgin Falls dam, the Ogoki diversion and the Pine Portage GS by comparing the observed (i.e., actual) levels and flows with the computed natural levels and flows (i.e., what would have happened if all the alterations were never constructed).

A typical plot, from Appendix 4A.1, of the observed and computed natural levels for Lake Nipigon, from 1980 to 1989, is shown in Figure 4.4.1a along with the observed and computed natural discharge or river flow (see Figure 4.4.1b). Note the similarities in the pattern of the observed and computed monthly fluctuations on Lake Nipigon. However, examination of the average monthly Lake Nipigon observed and computed elevations, from 1950 to 1989 (post Pine Portage), as shown in Figure 4.4.2, shows some important differences. Of course the mean level is higher because of the presence of the dam. The observed mean is 0.62 m (2.02') higher than the computed natural mean. The magnitude of the average August peak level, above the mean, is similar for both the observed and computed data. The computed average natural level declines slightly more rapidly than the observed average value from September through to November and December. From January through to the low in April, the rate of decline of the computed natural level is less than the observed decline. The computed natural average monthly low in April is about 8 cm higher, relative to the computed natural mean, than the observed level for April, relative to observed mean level. The natural average monthly level begins to rise in May, while the observed monthly level stays low until it begins to rise in June.

From Appendix 4A.1, the estimated natural variation of Lake Nipigon, from 1909 to 1989, is 1.8 m (5.9'). The actual observed variation, from 1951 to 1992, is 1.95 m (6.4').

The computed natural monthly discharges or river flows, as shown in Figure 4.4.1b, are much less variable than the observed flows. The natural flows tend to have only one peak at freshet. The observed values tend to have multiple peaks.

4.5 FISHERIES

The following section reviews three of the factors (lampricides, introduction of exotic species and water level fluctuations) that have potentially impacted fish populations in the Nipigon River and Lake Nipigon. The potential effects of lampricides and competition with other species is only briefly discussed as the focus of this study is the water management plan.

LAKE NIPIGON

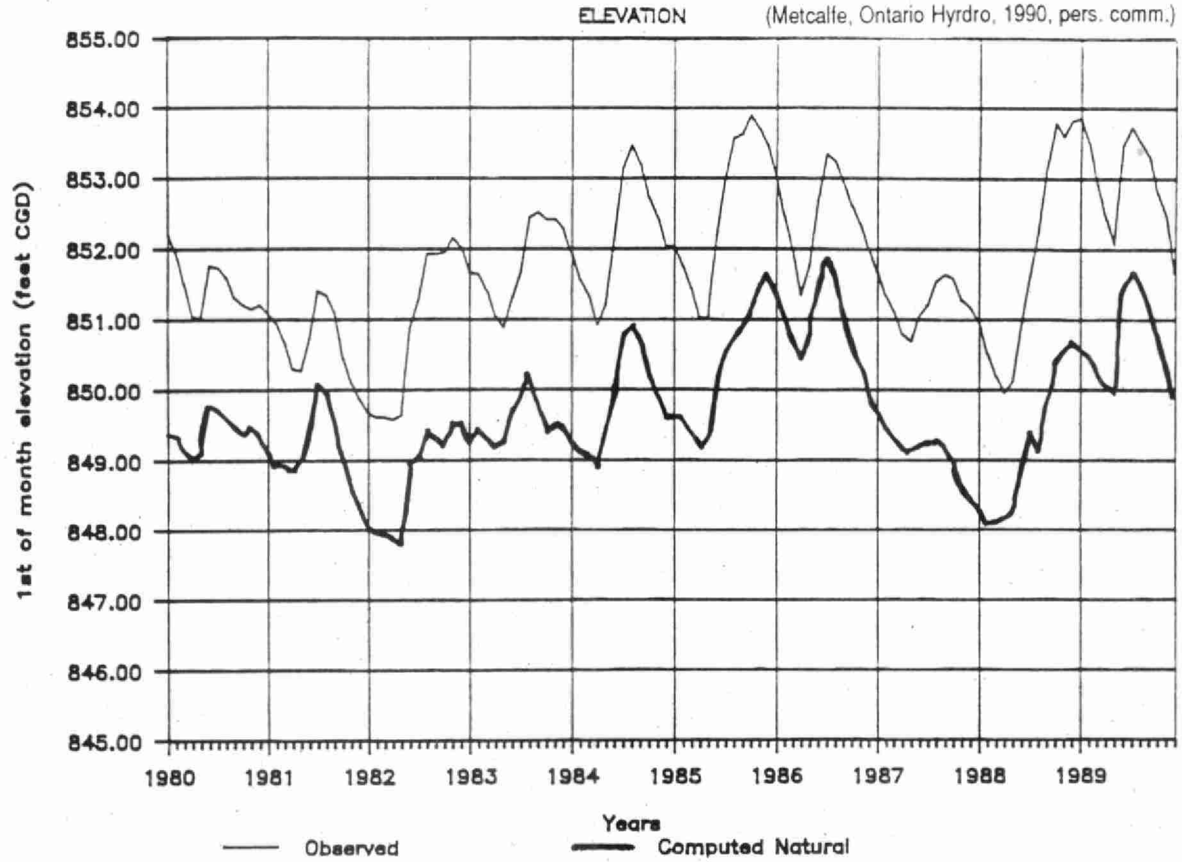


Figure 4.4.1a Lake Nipigon elevation , observed and computed natural 1980-1989

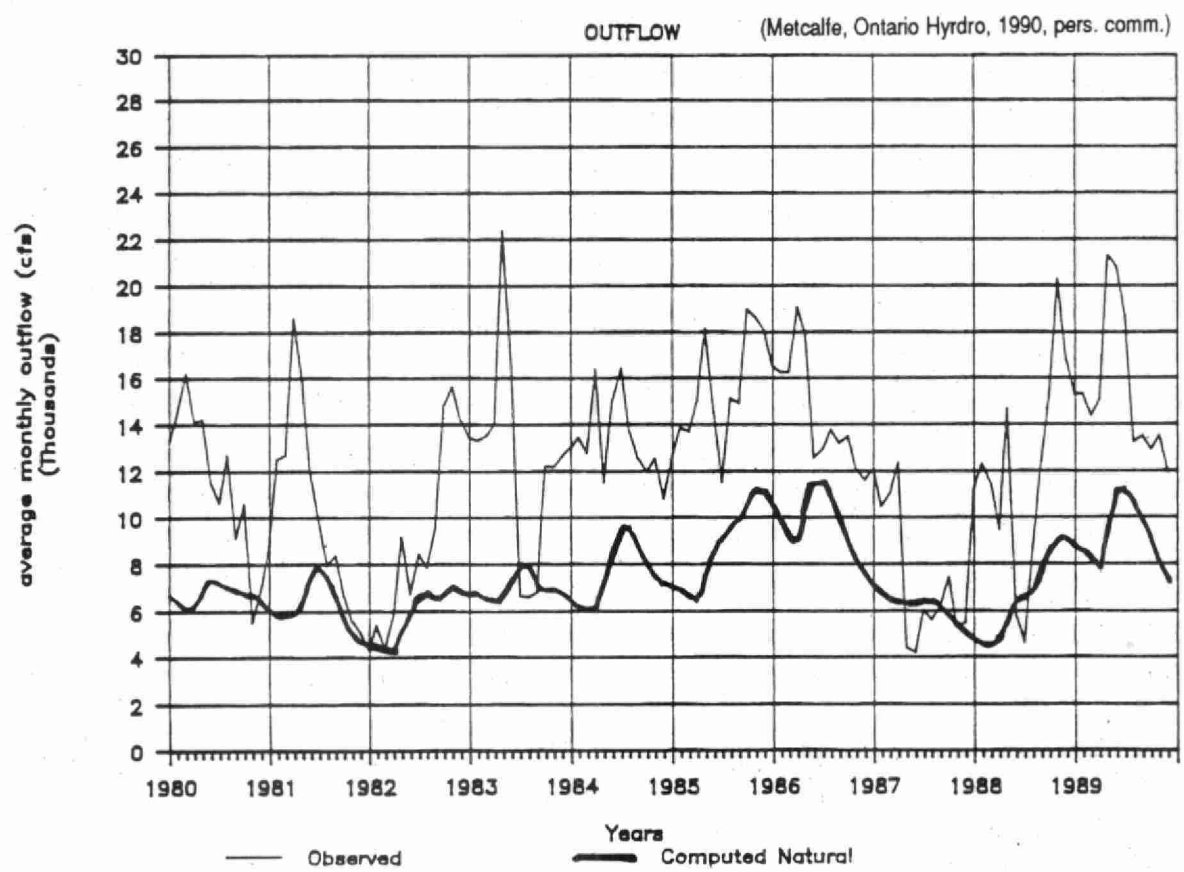
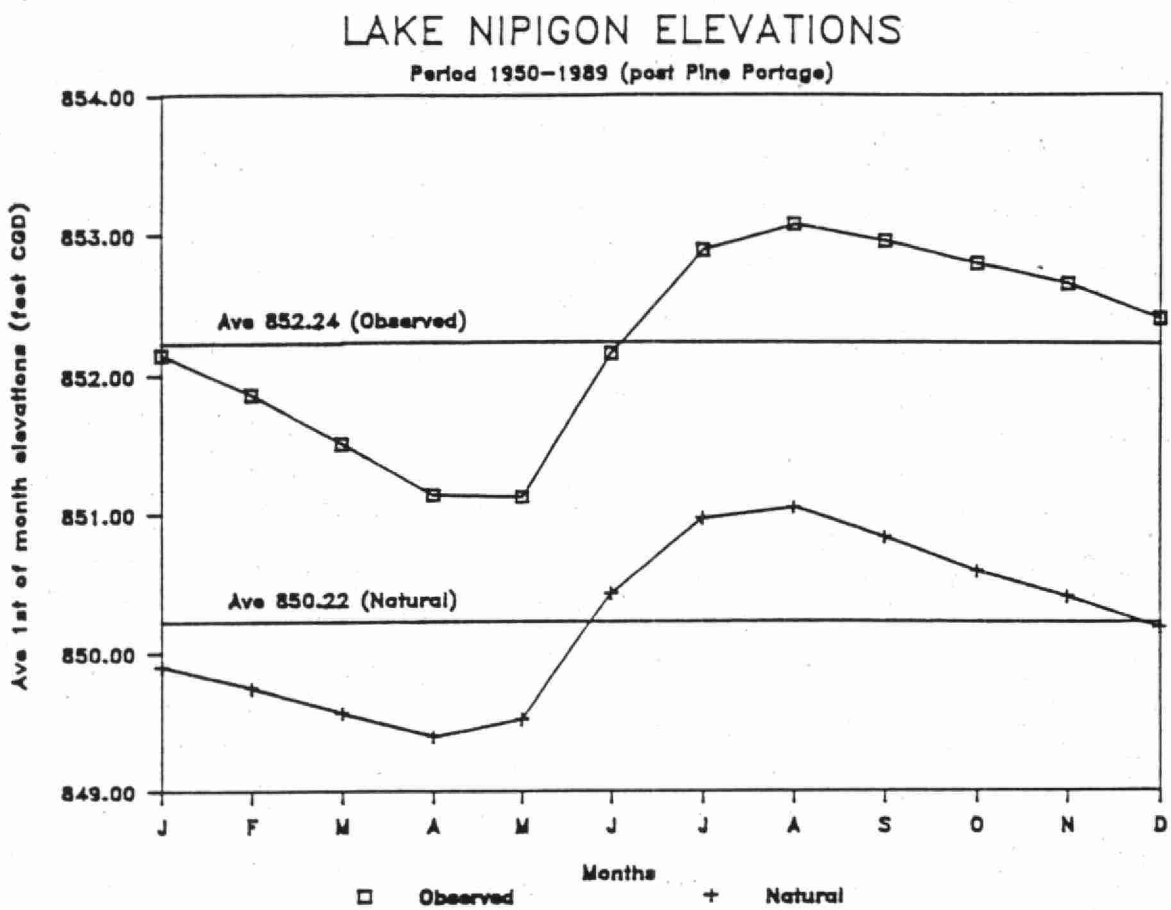


Figure 4.4.1b Lake Nipigon outflow, observed and computed natural 1980-1989



(Metcalfe, Ontario Hydro, 1990, pers. comm.)

Figure 4.4.2 Lake Nipigon elevations , average observed and computed natural 1950-1989 (post Pine Portage)

4.5.1 Lampricides

There have been six treatments of lampricide in the upper Nipigon River since 1964 and one treatment in the lower river (Table 4.5.1). The ratio of TFM to Bayer for the treatments averaged 98.52 parts TFM to 1.48 parts Bayer 73. The average time between lampricide treatments in the upper river is 5.6 years. Some long-time residents and anglers on the Nipigon River suggest that brook trout numbers began to decline after lampricide treatments began. They claim that the chemicals were not directly toxic to the trout, but did kill trout prey, notably sculpins. The reduced food base subsequently lowered trout numbers.

Table 4.5.1. History of Lampricide Use (TFM and Bayer-73) in the Nipigon River

Date	Year	Flow	Kg Active TFM Used	Kg W.P. Bayer Used	Mixture Ratio (TFM to Bayer)
Oct. 4-5	1964	108.8	15964	174	98.91
Sept. 6-8	1970	35.4	7832	2-4	97.40
Aug. 3-4	1975	50.5	6574	127	98.07
July 2-3	1981	67.6	7043	106	98.50
July 10-11 (lower river)	1983	67.4	61887	99	99.84
Aug. 21-22	1986	55.4	6652	101	98.46
Aug. 29-30	1992	52.5	5281	81	98.47

An in-situ bioassay was carried out by this study team in 1992 to determine the potential acute lethality of a 98:2 mixture of TFM (3-trifluoromethyl-4-nitrophenol) and Bayer 73 (the 2-aminoethanol salt of 2′, 5-dichloro-4′-nitrosalicylanilide) to juvenile brook trout and indigenous minnow species. The bioassay took place during an application of the 98:2 mixture by the DFO (Department of Fisheries and Oceans) at Alexander GS. On-site static bioassays carried out by DFO determined a target concentration of 2.0 mg/l of TFM in the river in a 98.4:1.6 mixture TFM to Bayer 73 wettable powder. The mixture was applied into the GS turbines starting at 8:00 am on August 30 and continued for 16 hrs. Figure 4.5.1 illustrates the in-stream TFM concentrations (ppm) as measured by DFO at a sampling station located immediately downstream of Alexander GS. Mixture of the chemical with river water was greatly enhanced by passage through the turbines.

Fish cages were placed at a control site located upstream of Alexander GS and at two downstream sites (Figure 4.5.2). Site 1 was located near the east shore of the TCPL pipeline crossing location and Site 2 was located immediately upstream of the railway bridge at Paramacheene. Two cages, each consisting of three compartments, were used at each of the three sites. One cage contained ten pearl dace (*Semotilus margarita*) in each of three compartments. The second cage contained ten young of the year brook trout in three compartments. This provided a 3 x 3 x 2 factorial design with three treatments (control and two test sites); three replicates (compartments) at each site east with n=10

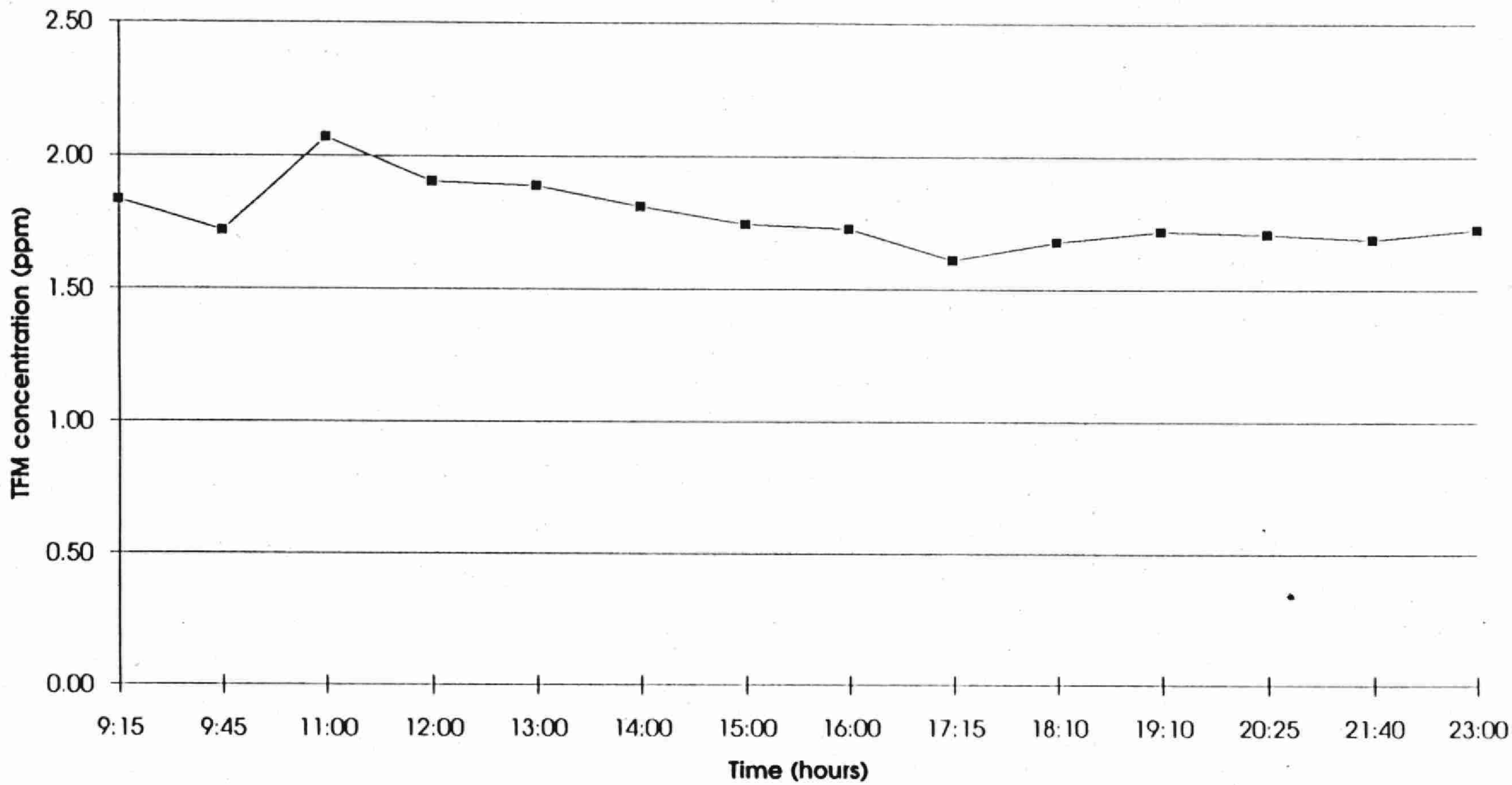


Figure 4.5.1 In-stream TFM concentrations as measured by DFO below Alexander GS. (August 30, 1992)

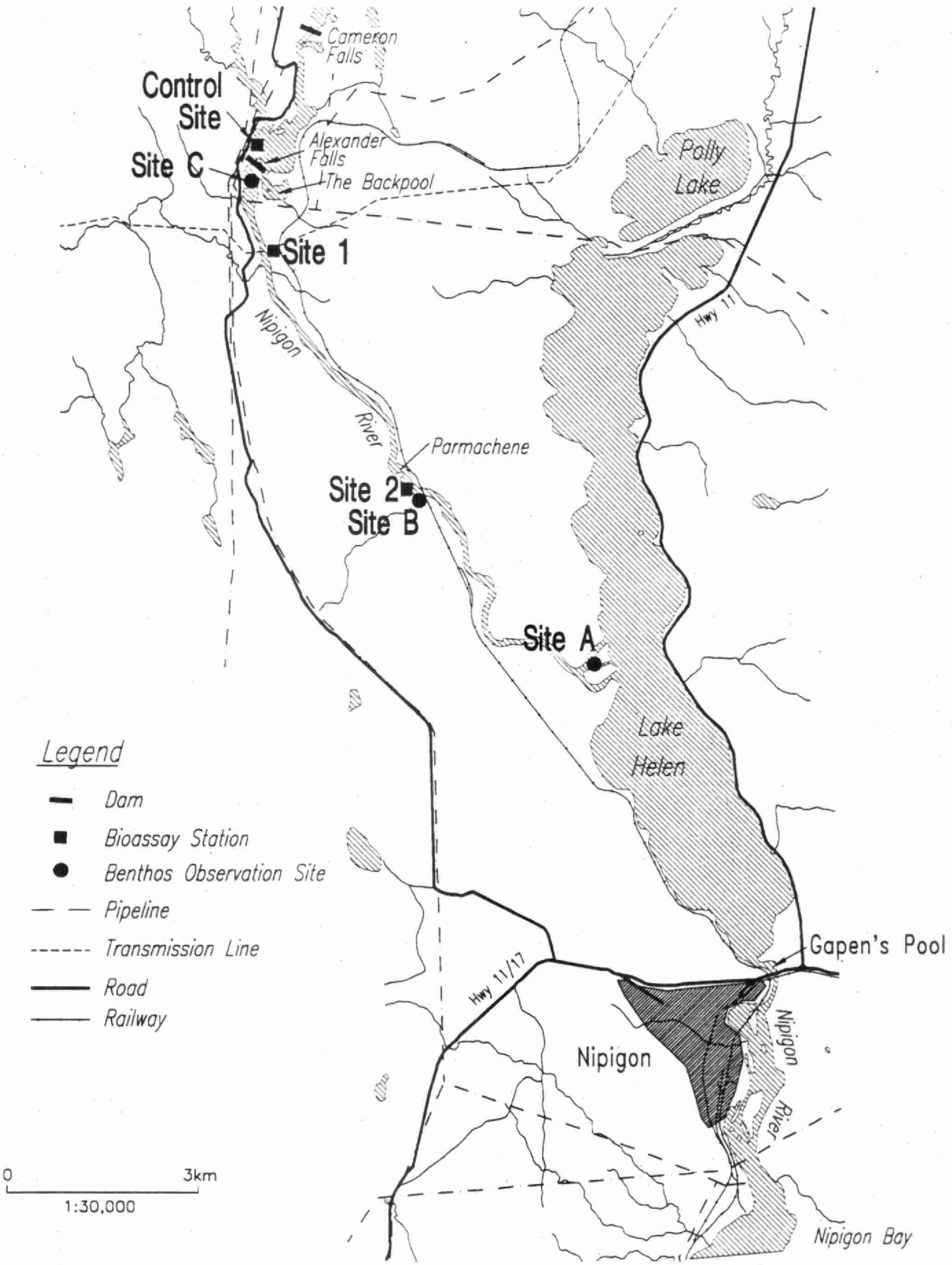


Figure 4.5.2 Location of fisheries field program activities

fish; and two species of fish. Thus, thirty dace and thirty brook trout were exposed at each test site. Brook trout were provided courtesy of the Ontario Ministry of Natural Resources (MNR) Fish Culture Station at Dorion on August 28. The pearl dace were purchased from a local baitfish supplier.

The fish were temperature acclimated in the cages for approximately 20 hours prior to the application of the TFM/Bayer 73 mixture at the control site. Initial temperature of the hatchery water was approximately 9°C. The cages were deployed at the test sites on August 29, 1992 between 0800-1000, and recovered between 1900 and 2020 on August 30. The river water temperature was 17°C at all locations.

Lampricide treatment did not affect trout or minnows during the bioassay. No mortality was observed in the 60 fish exposed at either of the 2 downstream test sites. At the end of the exposure period all fish appeared in good health and all swam away upon release. Results of this bioassay support the findings of a review of the aquatic toxicity of TFM which suggested brook trout and pearl dace have intermediate sensitivity to this chemical (NRCC, 1985).

Two dead lake trout (*Salvelinus namaycush*) were observed immediately downstream of Alexander GS and one dead lake trout was observed downstream of the TCPL crossing. A dead trout-perch (*Percopsis omiscomaycus*) was observed on August 30. A dead chinook salmon was found in about 0.5 m of water adjacent to the Bayer 73 application site in Lake Helen. Inspection of the fish revealed no angling or other readily apparent injuries or symptoms of stress/illness. However, there is no reason to believe the deaths were directly related to lampricide treatment.

There are some fish species found in the Nipigon River that have been identified as "most susceptible" to acute toxicity effects of TFM (NRCC, 1985). The species include suckers (*Catostomus* spp.), Perciforms (walleye, logperch and trout-perch) and sculpins (*Cottus* spp.). The review concluded, however, that observed acute effects were localized and minor with the exception of one species, the stonecat (*Noturus flavus*) -- a species not found in the Nipigon River System.

Casual observations of benthos in the Nipigon River during application of the 98:2 mixture revealed no obvious effects such as mortality or drift. The NRCC (1985) reported that aquatic invertebrates varied widely in their sensitivity to the 98:2 mixture but that even sensitive species have not been eliminated from streams treated every 3 to 4 years.

Based on the findings of this study there were no direct affects of lampricides to brook trout. Furthermore, there was no observable impact of lampricide applications on the macroinvertebrate population in the Nipigon River, although more detailed assessments are required to unequivocally support this observation.

4.5.2 Introduction of Exotic Species

Introduced species (chinook salmon, coho salmon, pink salmon and rainbow trout) have become established in the Nipigon River up to Alexander GS and rainbow trout are now the most commonly caught species (MacCallum 1989). Chinook salmon are also now highly prized by anglers as they enter the river in late summer in preparation for spawning in the fall. Introduced species may

compete with brook trout for food and spawning grounds and perhaps by feeding on juvenile brook trout.

Brook trout actively seek out areas of upwelling in which to construct their redds (Gunn, 1986; Curry *et al.*, 1992). Therefore, the total amount of the available brook trout spawning habitat in the study area is much less than that available to other salmonid species not requiring upwelling. Some salmonid spawning habitat requirements are presented in Table 4.5.2 (Adams and White, 1990).

Table 4.5.2. Spawning Requirements of Select Species

Species	Spawning Periods	Area Required per Spawning Pair (m^2)
Rainbow trout	early spring	0.8
Chinook salmon	early fall	13.4 to 20.1
Coho salmon	fall	11.7
Pink salmon	late summer/early fall	0.6
Brook trout	late fall	?

Observations by local MNR staff indicate there are only 20-30 active brook trout redds observed within the study area (R. Swainson,MNR, pers. comm. and Pope and Metcalfe, 1991, draft). Admittedly, there could be redds in deeper water that cannot be seen from the surface but extensive efforts to locate redds by swimming and radio telemetry has failed to locate any (R. Swainson, MNR, pers. comm.). Furthermore, given the spawning depth preference for brook trout is $<$ 50 cm (HSI data - Raleigh, 1982), the potential number of redds in deep water is likely low.

More than one pair of spawning brook trout may use the same redd for egg deposition (redd superimposition). However, based on the known number of redds at this time the Nipigon River below Alexander GS likely supports fewer than 100 spawning adult brook trout (50 successful pairs). This is substantially less than the number of adult salmon and rainbow trout that could spawn in the study area.

The following discussion review some studies documenting competition between brook trout and other introduced salmonid species. Some of the studies are directly applicable to this study which encompasses coastal brook trout in Lake Superior entering a river to spawn. Other studies consider only streams but the dynamics to inter species competition are relevant.

Brook trout are the only river-run salmonid species indigenous to the northern shores of the Great Lakes (MacCrimmon and Campbell 1966). However, their range has been substantially reduced during the past century and competition with introduced species, especially rainbow trout (*Salmo gairdneri*) has been largely implicated in the decline (Power, 1980). Larson and Moore (1985) reviewed the distribution of sympatric, or overlapping, populations of brook trout and rainbow trout

in the southern Appalachian mountains. In the absence of other external pressures (ie. logging, fishing) rainbow trout have encroached on brook trout habitat since the early 1900's. The authors suggest that due to competition with rainbow trout the brook trout will ultimately be reduced to headwater refugia, if not totally eliminated if management actions are not taken to protect the brook trout.

Cunjak and Green (1983) observed that the abundance of brook trout was several times lower in Newfoundland streams where rainbow trout were present compared with streams where rainbow were absent. Rose (1986) studied sympatric populations of young of the year brook trout and rainbow trout in the Goulais River, which flows into Lake Superior near Sault Ste. Marie, Ontario. The density of newly hatched brook trout was $0.5/m^2$ during the first few months. During the first summer the small brook trout generally inhabited water less than 40 cm deep with a flow less than 20 cm/s. By the first September, rainbow trout and brook trout were the same size even though the rainbow trout eggs hatched in early June, 4-6 weeks after the brook trout. Perhaps most significant was the observation that the growth rate of the young brook trout declined dramatically after the rainbow trout emerged. The composition of diets of the small rainbow and brook trout were similar. Johnson (1981) also reported that the diets of hatchery rainbow trout and small brook trout overlapped significantly. Rose (1986) reported that survival of brook trout over the first winter was very low, and may be aggravated by reduced growth rate during the first summer as a result of competition with rainbow trout.

The potential negative impacts of coho salmon on brook trout spawning was recognized in Michigan at least 20 years ago (Avery 1974; cited in Johnson 1981 and in Fausch and White 1986). In tributaries to the Great Lakes in Michigan coho salmon generally emerged 2-3 weeks before brook trout (Fausch and White 1986). During the first summer coho were generally longer (11-46%) and heavier than sympatric brook trout. In experimental trials, young coho salmon clearly outcompeted brook trout of similar size for food and preferential positions (Fausch and White 1986). The brook trout were displaced into less profitable habitats and subsequently grew poorly. The authors reviewed several mechanisms by which introduced salmon and native brook trout might compete, and suggest that competition among juvenile salmonids is the interaction most likely to have long term impacts on the resident trout populations.

In summary, laboratory studies and field investigations clearly show that both rainbow trout and coho salmon can outcompete sympatric populations of native brook trout. Competition among the young fish is particularly important, and detailed studies in the Nipigon River are required to better define the relative importance of competition in limiting brook trout numbers. Such studies or further consideration of the issue are beyond the scope of this water management study but competition cannot be overlooked within the broader context of establishing the fisheries carrying capacity of the river as it pertains to brook trout.

4.5.3 Water Level Fluctuations

Observations of Dewatering on Fish and Benthos (1992 - Flow Test)

This section provides an overview of observations made by the study team on fish and benthos during a rapid water level reduction in the Nipigon River in 1992. Comments specific to brook trout spawning habitat are discussed in the next section.

Between August 27 and August 31, 1992, Ontario Hydro reduced water flow at Alexander GS from approximately 500 m^3/s to approximately 65 m^3/s. The flow reduction was needed to allow application of lampricides by the Federal Department of Fisheries and Oceans. Photographs 4.5.1 to 4.5.6 show some of the effects of the dewatering.

During the dewatering period areas of exposed river bed were measured with a tape from the waters edge to the normal full bank height. Specific areas included the landing below Alexander GS, Paramacheene (see Photo 4.5.1) and the exposed sand bank at Gapens Pool. In addition, colour air photography (1:4000) was taken of the upper and lower river at low flow on August 29 as arranged by the RAP Coordinator in Thunder Bay. The substrate exposed at low flow between the Alexander GS and Lake Helen was digitized into GIS and its area calculated.

Many riverine fish and invertebrates have a limited range of conditions to which they are adapted. Rapid fluctuations in flow, such as these that occur downstream of Alexander GS, can reduce the abundance, diversity, and productivity of these organisms in exposed substrates (Chushman, 1985). The observations made of benthos in the exposed substrates of the Nipigon River concur with the literature. The observations are summarized descriptively in the following sections and numerically in Table 4.5.3.

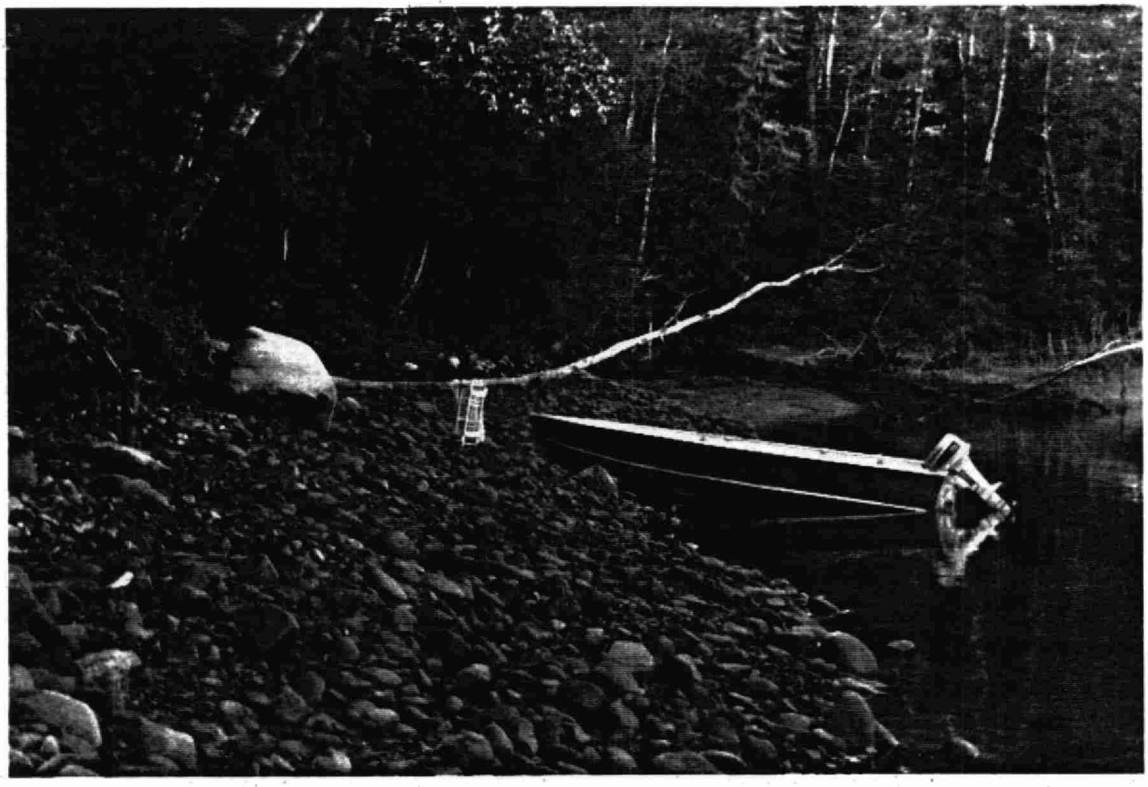


Photo 4.5.1 Brook trout spawning habitat exposed at Parmachene during water drawdown

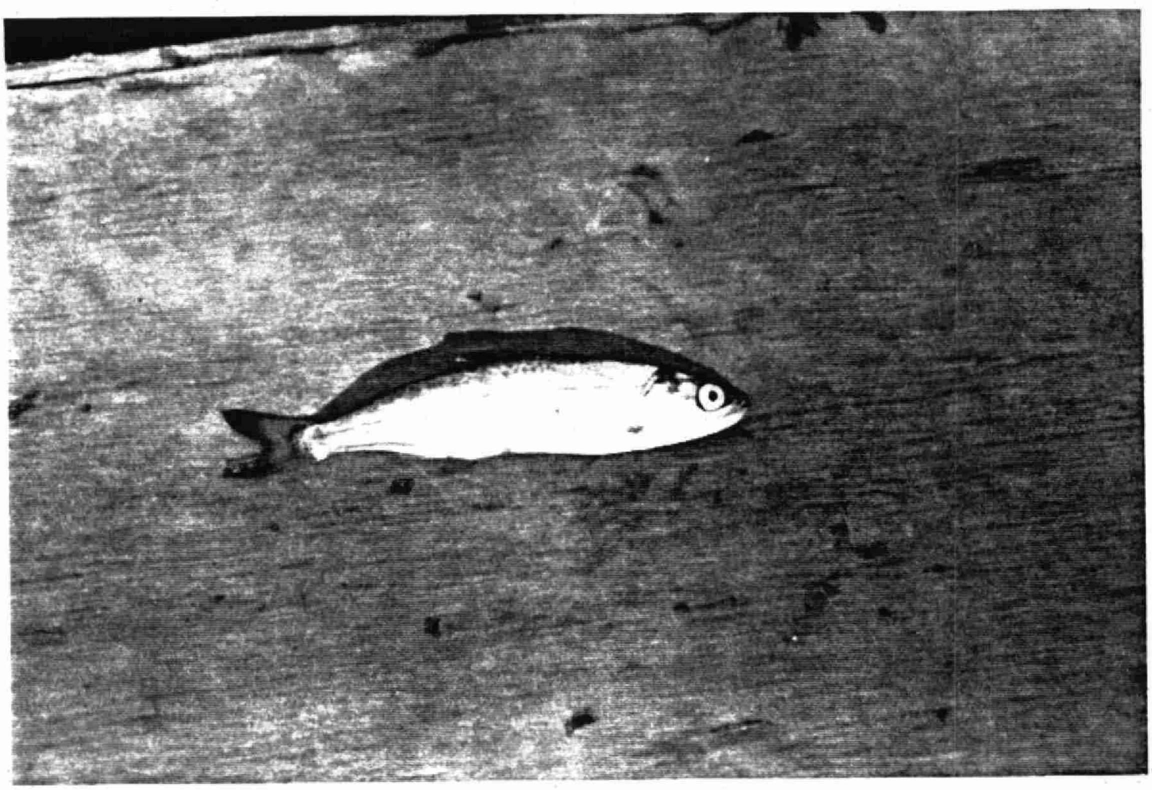


Photo 4.5.2 Dead salmon parr stranded at Parmachene during water drawdown August 28-29, 1992

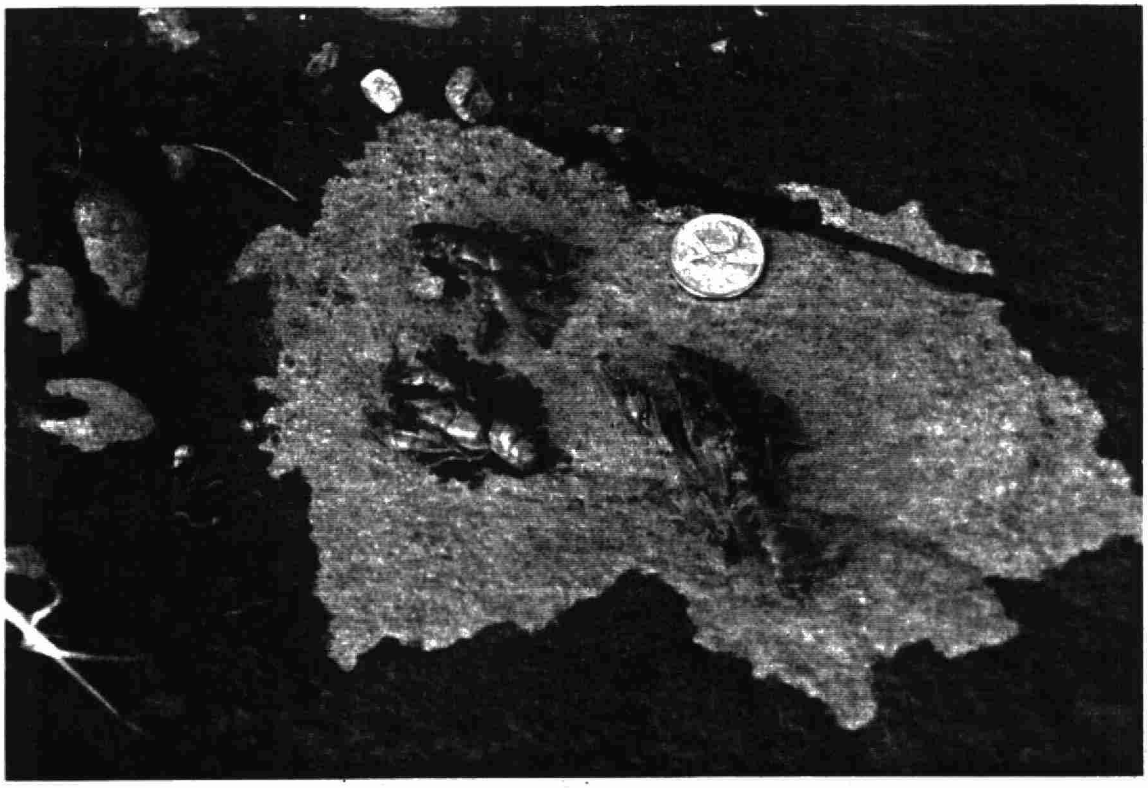


Photo 4.5.4 Dead crayfish stranded during water drawdown

Photo 4.5.3 Dead sculpins stranded during water drawdown

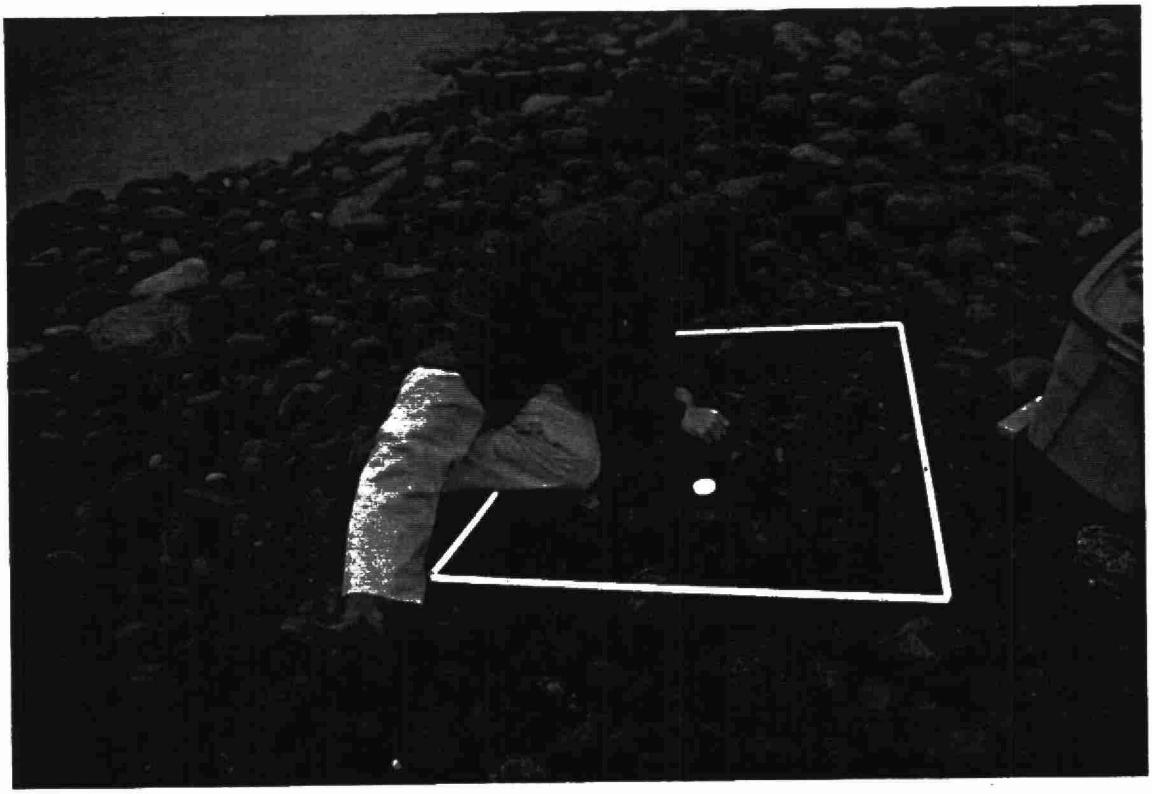


Photo 4.5.5 Counting benthos in quadrats during water drawdown

Photo 4.5.6 Shoreline erosion along Nipigon River

Table 4.5.3. Observations of Benthos in Exposed Substrate at Three Sites During Dewatering on the Nipigon River, August, 1992.

Location	Sample Substrate and Size	Benthos Observed	Comments
Site A: Sample 1 Flats at Delta entering Helen lake	Exposed sand and mud; 1x1 m transect .	Mayflies - 26 Pisidium - 3 Gastropids - 19 Empty caddisfly cases - 4 Midge - 1 Backswimmers - 13 Worms - 7 72	All backswimmers observed adjacent to water. 45% of mayflies further from edge of water were dead. There were no mortalities closer to water.
Site B: Sample 2 Immediately upstream of Paramacheene Bridge	Exposed rubble, ¼ of 1x1 m transect sampled	Large numbers of caddisflies 217 Midges - 30 247	Emerging caddisflies observed. Dried sculpins observed on the exposed rubble and boulders (outside of transect)
Site C: Sample 4 Immediately d/s of Alexander Falls G/S	Exposed rubble (80%) with some gravel, coarse sand and boulder, 1x1 m transect	Caddisflies - 10 Midges - 17 Annelid - 1 Leech - 1 Pisidium - 1 30	Many caddisfly cases, but almost all empty. Stones and cases were much drier than at Paramacheene. 2 dead crayfish and a sculpin observed in transect. Most insects were dead.
Site C: Sample 5 In running water of channel near crib d/s of Alexander Falls G/S.	Rubble in 15 cm of water. Benthos collected off one rock, 16x16x18 cm	Lots of caddisflies in cases 143 Midges - 4 147	Caddisflies appeared in very good condition with no apparent effects of TFM
Site C: Sample 6 Downstream of Alexander Falls on sand bar.	Sand and silt, 2 shovel scoops taken approximately 2 m from the eastern edge of the bar.	Mayflies - 2 Worms - 2 Isopod - 1 Gastropods - 20-40 ~ 45	Mayflies and gastropods were alive, but in poor condition.

Observations of benthos were made in the mud flats of the delta where the Nipigon River enters Lake Helen. The substrate within 0.5 m of the waters edge was moist and the mayflies observed in this area were in obvious distress and exhibited little filament movement. Almost half of the mayflies observed in the drier substrates further from the waters edge were dead. Mayflies located underneath rocks and logs that were still moist did not appear distressed. Many mayflies burrowed into the

substrate and may have reached water as the insects were not observed at the end of the burrow. Freshwater mussels that were exposed were in good condition and considering the wet cool weather conditions would likely easily survive 24-36 h until water levels were restored.

At Paramacheene (Site B, sample 2), large numbers of caddisflies observed on the underside of exposed rubble were alive. Although the caddisflies were removed from their cases, the insects were very responsive and would also likely survive the low water period as the underside of the rubble remained moist. Three dried sculpins were observed on the exposed rubble. A dead chinook salmon parr was also found in exposed substrate (see Photo 4.5.2). Other stranded fish and crayfish were scavenged by gulls before our observations were made. Very few invertebrates were collected among sand and gravel immediately adjacent to the water on the west shore by the railway bridge (Site B, sample 3). The organisms may have moved into the water after levels had dropped. Alternatively, the coarse character of the substrate may have precluded colonization in large numbers by mayflies and the absence of ruble precluded colonization by caddisflies. Pope and Metcalfe (1991,draft) reported "millions" of caddisflies were left exposed during water drawdown at this site in 1990.

The exposed rubble immediately downstream of Alexander GS (Site C) was much drier than the similar substrate observed at Paramacheene, perhaps due to the longer exposure time. Many caddisflies and other insects were observed dead (Site C, Sample 4). Caddisfly cases were quite desiccated. Two dead crayfish (see Photo 4.5.3) and a sculpin were collected within one quadrat. In the eddy with running water between the exposed rubble and west shore, however, caddisflies were abundant and in very good condition (Site C, Sample 5). The MNR collected 432 dead sculpins within a 2.5 m^2 area at this location during the dewatering period (see Photo 4.5.4). The dead sculpins were representative of all age classes (see Figure 4.5.3).

The invertebrates collected from a small sample on the sand bar at the boat launch downstream of Alexander Falls (Site C, Sample 6) were similar to those observed at the delta. Mayflies on the sand were alive but in obvious distress and with little filament movement. Some of these insects would not have survived the low water period.

The area of substrate exposed at low water between the Alexander GS and the start of the delta at Lake Helen as measured from air photos is shown on Table 4.5.4. During an extreme low flow event approximately 20 percent of river substrates are dewatered and benthos located there subject to desiccation (see Photo 4.5.5).

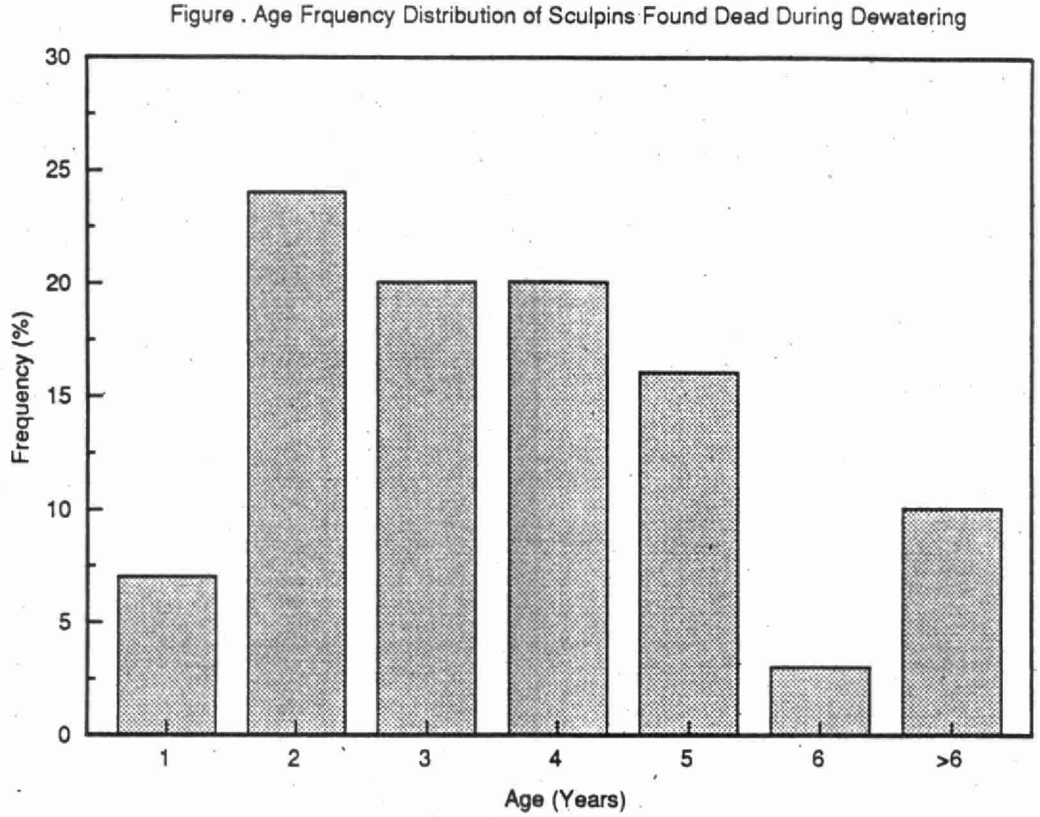


Figure 4.5.3 **Age frequency distribution of sculpins found dead during dewatering**

Table 4.5.4. Area of river substrate between Alexander GS & Lake Helen exposed at low flow (m^3/s = cubic metre per second)		
Item	**Surface Area**	**Percent of Bank-full River**
Water surface at bank-full height (350 to 500 m^3/s)	135.6 ha	100%
Water surface at low water (70-113 m^3/s)	108.5 ha	80%
Substrate exposed at low water (70-113 m^3/s)	27.1 ha	20%

The total number of organisms counted in each 1 m^2 quadrat ranged from approximately 30-247 (Table 4.5.3). These numbers are likely conservative since many burrowing species would escape detection. The benthic organisms ranged in their condition based on duration of exposure and ability to stay in wet crevices. Almost 100% mortality can be assumed for prolonged exposure, or even short exposure during harsh (eg. freezing) conditions.

Previous research has shown that rapid fluctuations of water levels in rivers downstream of power plants reduces the abundance, diversity and productivity of benthos. The analysis of air photos revealed that a 70 m^3/s water flow exposed approximately 20 percent of the substrate normally covered in fully wetted situation (at 350 m^3/s). Operation of Alexander GS as a peaking facility (fluctuations between 350 and 70 m^3/s) could reduce insect populations substantially since the relatively shallow near shore areas are the most biologically productive. These same areas are also most prone to the impacts of water level fluctuations.

4.5.4 Impacts of Water Level Fluctuations on Brook Trout Spawning Habitat

The federal *Fisheries Act* is quite explicit in declaring that destruction of fisheries habitat is prohibited (Section 35(2)). Under the Act fish habitat is broadly defined to encompass a wide range of conditions. Dewatering of spawning substrate, particularly that containing fish eggs and newly hatched juvenile fish would be considered under the Act as destruction of fisheries habitat. Under the Fisheries Policy for the Management of Fish Habitat, avoidance of this situation is preferred, followed by Mitigation and then Compensation.

The water level fluctuations that must be addressed include not only the peaking operations but also drawdown for maintenance (should be done at non-critical fisheries times) and other purposes.

Jessie Lake

The MNR reported that brook trout spawning studies were conducted on Jessie Lake upstream of Cameron Falls in the fall of 1990. Redds have been identified at levels ranging from 226.75 to 226.98 m (letter from Q. Day, MNR, to B. Lomenda, Ontario Hydro, Jan. 8, 1991). Based on this information, water levels below about 227.0 m on Jessie Lake would expose brook trout redds, which would result in the destruction of fish habitat.

Lake Nipigon Spawning Habitat

Fluctuating water levels may affect brook trout recruitment by two mechanisms:

a) drawdown: low levels exposure incubating eggs; and
b) high or fluctuating levels increase erosion and cause siltation of redds. (see Photo 4.5.6).

The potential effect of drawdown can be examined by comparing water levels with estimated redd elevations. For the period 1945 to 1985, Ritchie and Black (1988) calculated that redds at West Bay were potentially exposed only three times in 1972, 1976 and 1982 (Figure 4.5.4). Since then to 1990, water levels dropped below the minimum operating level of 259.3 m again in 1988.

The MNR previously reported that known redd elevations at South Bay ranged from about 258.4 to 259.39 m. However, a recent survey (April 29, 1993) suggest the highest redd occurs at about 259.83 m This depth was calculated from the Ontario Hydro water level at Macdiarmid for that day. Newly hatched brook trout were observed to be stranded above the water level on the day of the survey (water level reported at 259.57 m). During the period October 1989 to May 1990 it is apparent from Figure 4.5.5 that redds 259.8 m would have been exposed for most of the time.

Historical water levels in Lake Nipigon at 10 year intervals beginning in 1951 (Appendix 2B) were compared with the highest known redd elevation at South Bay. From this comparison the water level was less than 259.83 for the following proportion of time:

Time Interval	% time redd exposed
1951 - 1960	34.7
1960 - 1970	45.3
1971 - 1980	57.7
1981 - 1990	62.2

In summary, direct impacts to known brook trout spawning sites on Lake Nipigon will occur at water depths less than 259.83 m.

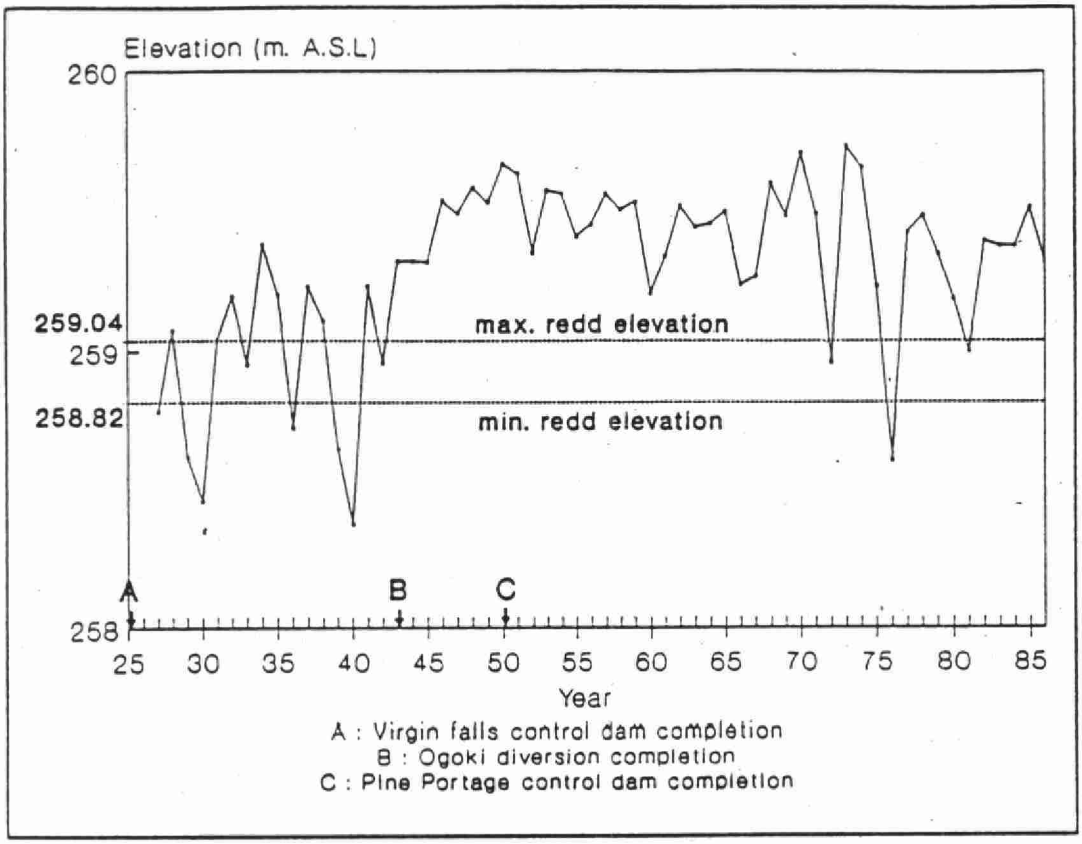


Figure 4.5.4 **Minimum water levels (Oct.-May) measured at Macdiarmid compared to West Bay redd elevations (from Ritchie and Black 1988)**

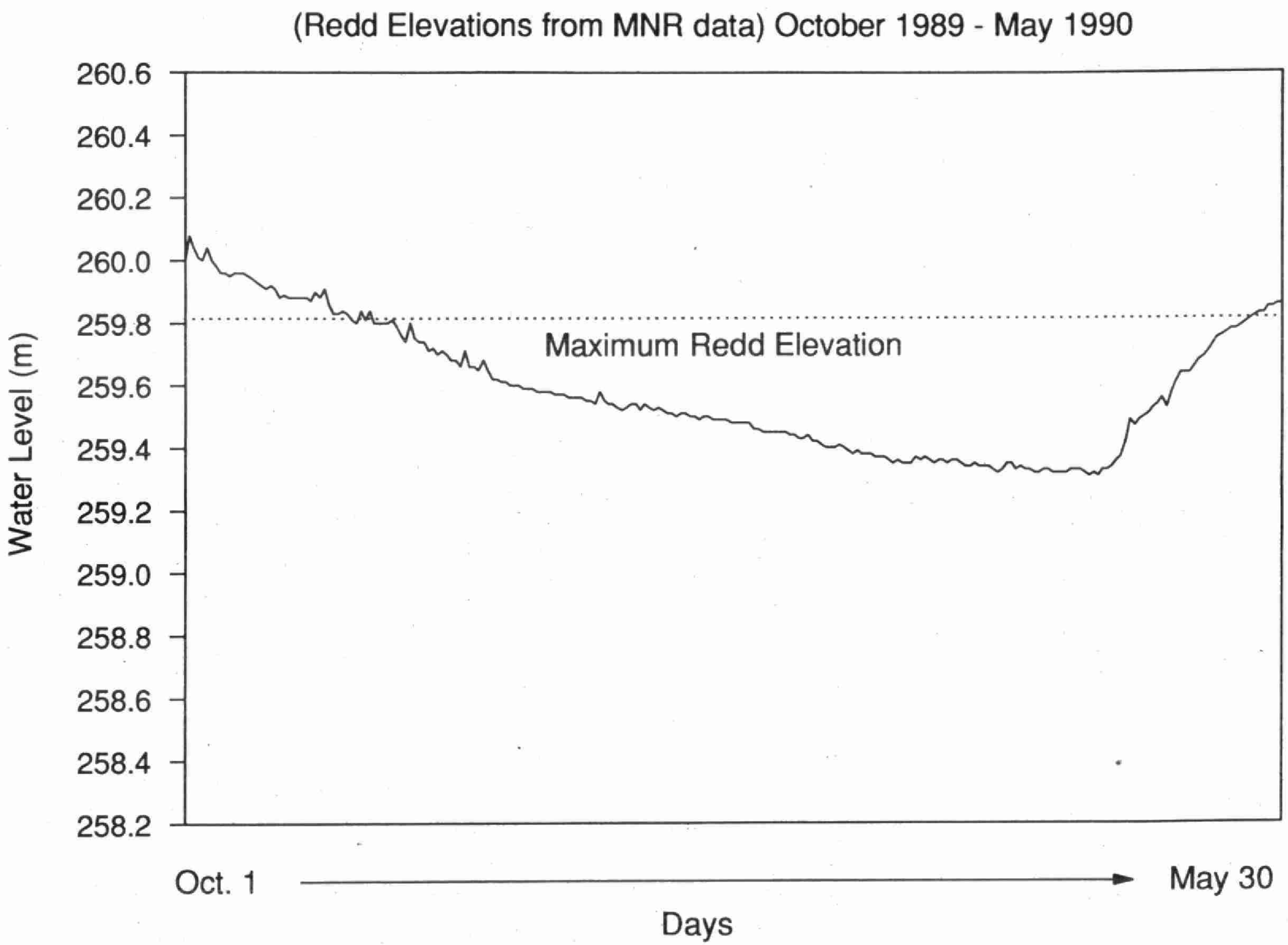


Figure 4.5.5 Lake Nipigon daily water levels at Macdiarmid, October 1989 to May 1990 compared with maximum measured redd elevation at South Bay

Nipigon River Spawning Habitat

To examine the potential impact of water fluctuations on brook trout spawning habitat in the Nipigon River, the minimum daily water flow, using hourly flow records, was plotted. Hourly data were available only from Ontario Hydro (R. Vinski. 1993. pers.comm.) from January 1986 to December 1992 for Alexander GS (Figures 1- 8, Appendix 4B). Data are plotted from October 1 of each year to May 30 the following year. This period encompasses brook trout spawning and the egg incubation period.

It is readily apparent that water flows were often below 170 m^3/s during the three year period 1986 to 1988 (Figures 1-3, Appendix 4B). From the preceding descriptions it was shown that many trout redds are exposed at flows less than 170 m^3/s. Therefore, substantial impacts on brook trout recruitment likely occurred during these three years. For example, in the fall of 1987 and spring of 1988, minimum water flows were consistently below 113 m^3/s.

From October 1988 to May 1989, water flow was mostly above 300 m^3/s and never fell below 250 m^3/s (Figure 4, Appendix 4B). Therefore, brook trout recruitment would be expected to be good that year. Water flow was again low during the spring of 1990 (Figure 5, Appendix 4B) when the landslide occurred. Beginning in 1991, Ontario Hydro agreed to maintain the instantaneous flow of 260 m^3/s at Alexander GS from October to May 15. Daily averages do not necessarily protect the fish or eggs from hourly fluctuations and periods of dewatering. Since October 1990, water flow has been maintained generally above 250 m^3/s up to December 1992 (Figures 6,7,8, Appendix 4B). The peaks of Figure 8 (Appendix 4B) are flattened because Ontario Hydro was spilling excess water. The spilled water was measured but is not shown in Figure 8. The actual flow is greater than 350 m^3/s.

Studies have documented that fluctuating water regimes due to hydroelectric development can reduce fish biomass and diversity in rivers (Ward and Stanford, 1983; Bain et al 1988). Cushman (1985) reviewed the ecological impacts of varying flow regimes downstream of hydroelectric dams and cited two studies that reported reduced survival of salmonid eggs due to fluctuating water levels (Fraley and Graham, 1982; Fraser, 1972 cited in Cushman, 1982). Curry et al (1992) recommended that a water flow of 250 m^3/s should be maintained in the Nipigon River to protect spawning and incubating eggs. Our analysis suggests that minimum water levels were substantially below 250 m^3/s, and below 170 m^3/s for critical periods between 1986-1988, and again in the spring of 1990. Impacts on brook trout recruitment during those periods can be expected. Detailed studies on the age distribution of brook trout in the Nipigon River would confirm if certain year classes have been affected by certain patterns of water regulation during recent years.

Summary of Impacts at Specific Sites

Alexander Back Pool

Spawning redds occur at elevations of approximately 184.4 to 185.31 m at this location. Water levels for flows of 113 m^3/s and 350 m^3/s are 184.04 m and 185.81 m, respectively (Figure 2.1.3). Therefore all known redds would be exposed at 113 m^3/s.

Parmacheene

Active redds are at elevations of approximately 184.2 m. At 350 m^3/s, the water level is about 185.17 m and there is no exposed river bed. The first redd becomes exposed at about 250 m^3/s.

Gapens Pool

Brook trout redds at this site are between elevations of about 182.71 to 183.7 m. At 113 m^3/s the river elevation is 183.21 m (Figure 2.1.3). The water level at 350 m^3/s is approximately 183.96. In 1989, brook trout spawned at about 350 cms in depths of water ranging from 0.24 to 1.25 m.

In summary, impacts to known brook trout redds within the Nipigon River will occur at water flows below approximately 260 m^3/s. Impacts to other fish species and benthos can also be expected.

Conclusion

There have been several activities historically that have likely contributed to the decline of fisheries within the Nipigon area. The relative importance of all these various activities in the decline of brook trout populations in the river and in the lake is difficult to evaluate. However, the focus of this study is to examine the impact of water level fluctuations on fish habitat, and to identify water management strategies that can protect or enhance the fisheries. It is clear that water fluctuations within the Nipigon system below certain levels will destroy fish habitat which contravenes the *Fisheries Act*. Mitigation of this situation will have to take into account other resource users in the area as well as the social and economic costs of the mitigation measures.

4.6 LAKE NIPIGON MEASURED WATER LEVELS

As discussed in Section 2, water levels for Lake Nipigon have been measured at Macdiarmid since 1927 and at Wabinosh Bay since 1986. It should be noted that levels used in this report are from the Macdiarmid records unless otherwise specified.

There was a strong opinion voiced by a number of the stakeholders that the water levels that are "reported" to them for Lake Nipigon should not be the average of the recorded levels at the Macdiarmid and Wabinosh gauges. The stakeholders felt that by averaging the two levels from opposite sides of the lake, the actual water level at the southeast shore was not correctly represented due to storm surge. During a strong northwesterly blow, the people along the southeasterly shoreline experience the "mean" water level plus the storm surge. Even if the "reported" water levels are not the average of the two gauges, daily mean levels at Macdiarmid, as recorded, will not show the full effects of storm surge. One stakeholder summarized it as follows:

> "Ontario Hydro gauges may record levels within their negotiated allowance but the actual level experienced through wave action and 'tilting of the lake' [storm surge] along the shoreline is much greater than the recorded height of the water at the gauges."

The wording of the 1974 Licence of Occupation No. 7785 (see Chapter 2, Section 2.1.4) states that Ontario Hydro can not cause any land above elevation 260.6 m (855.0') to be "overflowed". The precise definition of "overflowed" needs to be clarified as this is of concern to shoreline property owners. Present draft MNR policy for the Great Lakes shorelines recognizes the "flood level" as the combined result of the still water level and the storm surge. Further, any subsequent Licences of Occupation need to be examined to check and see if any changes have been instituted.

For this study, the mean daily water level records for Macdiarmid and Wabinosh were reviewed. An example of the comparison between the two gauges, for a period in 1986, is presented in Appendix 4C. Based on the review of the records, the average difference between the daily records for the two gauges was only 0.9 cm and the largest difference was 24 cm. It should be noted that on one side of the lake the water level would be about 12 cm higher than the "mean" level and the other side about 12 cm lower, for a total difference of 24 cm. These results are similar to those of Ritchie and Black (1988). They reported a difference of up to 5 cm to 15 cm between the minimum monthly water levels at Macdiarmid and Wabinosh from January 1986 to June 1987.

It was reported (MNR, 1989) that a storm of sufficient intensity to cause 1.0 to 1.2 m (3 to 4') high waves at Poplar Point Park occurred on November 1, 1989. The daily mean water levels records at Macdiarmid and Wabinosh for this date were 259.91 m and 259.90 m respectively.

Further analysis, using hourly records if available, or computer simulated surge (if adequate wind data available) is required to make a better estimate of the magnitude and frequency of storm surge on the lake.

4.7 FIRST NATION/ TRADITIONAL LIFESTYLES

Native people, who lived around Lake Nipigon and the Nipigon River long before anyone else came to the area and long before the dams were built, want to be more directly involved in the study. There is a distinct feeling that the Native community has been left out of the decision-making process. On-going dialogue and consultation with the First Nation Bands, as with all the stakeholders, is clearly desirable.

Comments received from individual members of the various First Nations are not the official position of their Band Councils. One Band has gone on record as saying comments by individuals should not be construed as part of any participation in studies regarding their community.

While there is some reliance on fishing and hunting for food, native peoples' concerns appear to centre on maintenance of the natural environment, the sustainability of the commercial fishing, and loss of traditional places and activities due to flooding by the dams. They see lake levels as part of the environment but are also concerned about water quality. The level fluctuations are not the only pressure on the fishery and the study should clearly identify the other pressures.

While members of the Native communities provided valuable information and comments, none of the Bands provided official positions on problems or concerns. However, the study team believes that many of their interests with respect to protection of the fisheries, erosion and shore property damage are similar to other stakeholders.

4.8 TOURISM/RECREATION

4.8.1 General

The Nipigon River Corridor Concept Planning Study (Moore/George, 1992) was undertaken "to generate concepts and ideas for capitalizing on the inherent potential of the river corridor". The consultants discussed tourism issues and opinions with local people involved in the tourism sector. One of the key issues that they identified was that "the most important tourism attraction the area has to offer is its landscape. Efforts should be made to protect and preserve its environmental and scenic qualities. Only those uses which are compatible and which do not adversely affect these resources should be encouraged." However, they further identified other key issues that need to be resolved to improve the tourism including: fragmented services and attractions, limited food and accommodation services and inadequate promotion and access. A more complete outline of the key tourism issues identified in the Nipigon River Corridor study and the public's comments during that study are provided in Appendix 4D.

Concerns that too many people coming to the Nipigon area would spoil the "wilderness" were mentioned. However, it was not the impression of the study team that this was a significant problem in the minds of the stakeholders. Certainly those who operate tourist facilities want people to come especially if they come to enjoy the "wilderness". In 1905 it was written (Alexander, 1911 in Wilson, 1991) that the Nipigon was "popularized" and "commercialized" to the point where it was

"paying the dread penalty of literary distinction". He wrote of "crowding portages with fellow tourists" and "bumping canoes continuously". "It is amazing that it took so few people to despoil such a great land in such a short length of time, something less than seventy years!".

4.8.2 Lake Nipigon Shoreline

Reduced loss of enjoyment and recreational use of the Lake Nipigon shoreline was expressed as a big concern by many groups, including:

- Cottage owners;
- Charter operators (whose clients enjoy beachcombing); and
- Bathers.

One shoreline property owner felt the ideal level of Lake Nipigon for the summer would be the level of the lake at ice-out. As shown in Table 2.1.1b, in Chapter 2, from 1951 to 1992, the average water level in May has been 259.63 m (851.9').

Photographs 3.3.4a and 3.3.4b show what was left of the municipal beach at the Poplar Point park on August 27, 1992. The recorded daily mean water level was 260.3 m (854.0'). At lower water levels, say 260.0 m (853.0'), the beach would be wider and more useable for tourists and locals during the prime summer months of July and August.

Tables 4.8.1 and 4.8.2, respectively, give an indication of how often the daily mean water level of the lake was greater than 260.0 m (853.0') and 260.3 m (854.0') during the prime summer months of July and August.

From Table 4.8.1, it can be seen that during the most recent two year time period, 1991-92, the mean daily water level has been greater than 260.0 m (853.0') for an average 45.4 percent of the time during the prime summer months of July and August. During the previous four decades, the average time varied from 44.9 percent, in 1971-80, to 88.9 percent, in 1951-60. The reader is also referred to Appendix 2A to see the pattern of water levels on Lake Nipigon.

The average percentage of time, by decade, that the mean daily water level was greater than 260.3 (854.0') has varied between 1.5 and 35.5.

Table 4.8.1 Percentage of Time in the Summer When Lake Nipigon Mean Daily Water Level Greater Than 260.0 m (853.0′)

	Percentage of Total Days		
Time Period	July	August	Average
1951-60	88.1	89.7	88.9
1961-70	70.5	75.5	73.0
1971-80	47.4	42.3	44.9
1981-90	50.0	55.8	52.9
1991-92	58.3	32.5	45.4

Table 4.8.2 Percentage of Time in the Summer When Lake Nipigon Mean Daily Water Level Greater Than 260.3 m (854.0′)

	Percentage of Total Days		
Time Period	July	August	Average
1951-60	21.3	11.6	16.5
1961-70	37.7	33.2	35.5
1971-80	10.0	14.5	12.3
1981-90	2.9	0.0	1.5
1991-92	0.0	5.0	2.5

4.8.3 Polly Lake

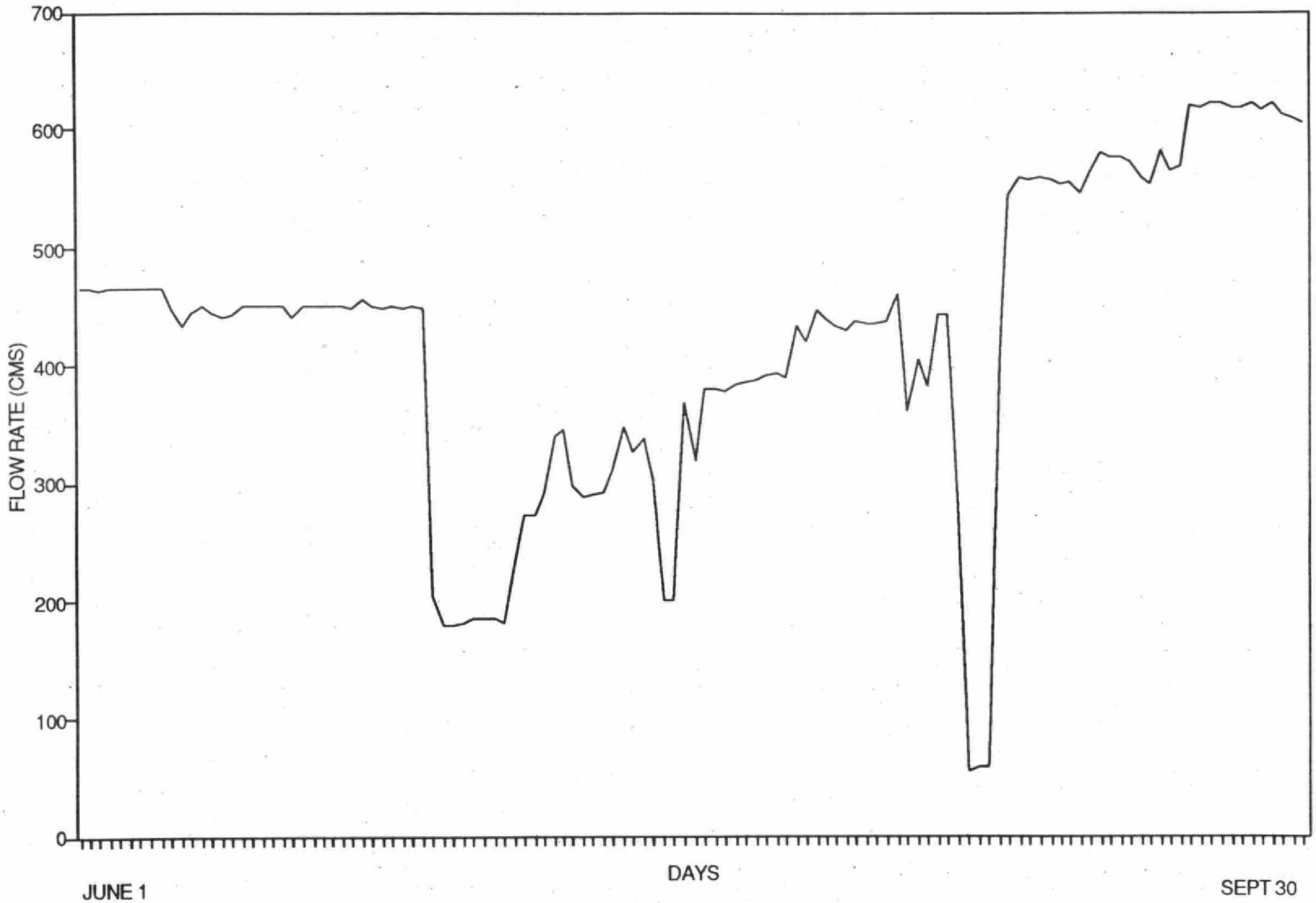
The fluctuations in the river flow results in significant water level and temperature fluctuations on Polly Lake. This greatly diminishes the use and enjoyment of the shoreline by the cottagers. Photographs 3.3.1a and 3.3.1b show flooding of the shoreline in September 1992. Damage to protection structures does occur.

It is clear that the cottagers on Polly Lake want the river flows to stabilized within an acceptable range. One cottager suggested a preferable range of 0.6 m (2′) with a range of 1.0 m (3′) being the maximum (i.e., at 3′, the beach is gone but the property is not damaged). Because there are no water level records for Polly Lake, it is difficult to establish what is the preferred range is in terms of actual elevations. There are records for Steamboat Bay on Lake Helen for a period in the late 1970's and from 1980 to 1987 (see Appendix 2B.3). As noted in Section 2.1.3, the study team will be relating the levels of Lake Helen to the discharge from Alexander GS during the second year of the study.

Another cottager said the level in June, July and the first half of August, 1992, was good and even - in fact, it was said that the level could have been even 0.3 m (1′) higher. However, the cottager said that the level in the later part of August and in September was too high. The average daily flow at Alexander GS from June 1 to September 30, 1992, is presented in Figure 4.8.1. A simplified comparison of the flows and the reported levels is presented in Table 4.8.3.

Table 4.8.3 Observations of Water Levels, Polly Lake, June to September, 1992

Nominal Time Period	Approx. No. of days	Approx. daily flow Alexander GS (m^3/s)	Comments
"June, July & first half of August"	35	450	higher than mean flow
	10	170	approx. half of mean flow
	27	330 (fluctuating)	slightly less than mean flow
"Second half of August & September"	17	417	higher than mean flow
	3	57	low flow
	31	580	much higher than mean flow



June to July (R. Vinski, Ontario Hydro, 1993, pers. comm.)
August to September (B. Lomenda, Ontario Hyrdo, 1993, pers. comm.)

Figure 4.8.1 **Nipigon River average daily flow rate at Alexander GS, June to September 1992**

From Table 4.8.3, one can see that in the first part of the summer the flows were higher and lower than the mean flow of about 350 m^3/s. Therefore, the comment that the levels on Polly Lake were "good and even" and "could have ben higher" is unexpected. In the last 51 day period, during the second part of the summer, when flooding was reported, one can see that the flows were high.

Information is needed on the actual elevations of the properties at Polly Lake. Additional discussion with the cottagers is required to establish other specific times in the past when levels were deemed to be good or bad.

4.8.4 Charter Cruise Operators and Navigation

Eight cruise operators on Lake Nipigon offer fishing and scenic tour charters. Thus the interests of the cruise operators include:

1) a healthy fishery;
2) water levels in the summer that are not too high to prevent beachcombing;
3) water levels that are not too high to increase of erosion of the shore which results in floating debris in the water which in turn creates a hazard to navigation;
4) water levels that are not too low in the summer - low levels increase risk of striking submerged rocks and shoals; and
5) water levels that are not too low in early May - causes difficulties in launching vessels.

Many of these interests are common with other stakeholders. Point 1) is discussed in Section 4.5. Point 2) was discussed earlier in this section, under the heading Lake Nipigon Shoreline and Point 3) is discussed in Section 4.9.

With respect to Points 4) and 5), it was not conclusively stated what level was considered too low for safe navigation. However, there were a few operators who indicated a preference for the lower level to be 259.37 m (851.0′) while others indicated this was too low. As noted earlier, Ontario Hydro operating directives, stated that elevations below 259.1 m (850′) cause difficulties for commercial fishermen and tourist camp operators.

Points 3) and 4) are representative of all those who navigate boats on the lake.

Table 4.8.4 shows that in the past, the daily mean water level of Lake Nipigon was only infrequently less than 259.37 m (851.0′) during the months of May through September.

Another concern expressed by cruise operators, as well as commercial fishing operators, was the difference was too great between the water level in September, when they stored their boats, and the following May when they launched them. Appendix 4E presents a comparison of the difference between the mean monthly September water level and the following mean monthly May level for each year from 1951 to 1990. The difference in levels ranges from -0.2 m to +0.8 m (-0.66′ to +2.62′) with an average decrease in water levels from September to May of 0.4 m (1.31′).

Table 4.8.4 Percentage of Time from May to September When Lake Nipigon Mean Daily Water Level Less Than 259.37 m (851.0′)

	Percentage of Total Days				
Time Period	May	June	July	August	September
1951-60	0.0	0.0	0.0	0.0	0.0
1961-70	6.6	0.0	0.0	0.0	0.0
1971-80	20.0	11.3	0.0	0.0	0.0
1981-90	26.1	0.0	0.0	0.0	3.0
1991-92	0.0	0.0	0.0	0.0	0.0

At present, Ontario Hydro operates with a self-imposed maximum discharge at Pine Portage of 566 m^3/s in order to minimize any risk to the footings of the CPR bridge at Nipigon. If the lower operating limit of Lake Nipigon is raised, the 566 m^3/s limit may have to be waived in order to observe the maximum limit of the Lake. This high discharge, which would probably last for several weeks, could lead to increased erosion on the river and could threaten the stability of two railroad bridges and one Provincial highway bridge. (ref. Ontario Hydro memo, "Concerns of raising Lake Nipigon minimum level", referenced in Ontario Hydro correspondence, November 20, 1991, E. Boni/B. Lomenda).

The flood storage capacity of Lake Nipigon is relatively limited. If the lower limit is raised, the storage capacity will be further limited. This will require higher discharges down the river in periods of high inflow. It will also increase the level of the Lake. Shoreline erosion around Lake Nipigon has historically been a problem (i.e., Gull Bay Reserve). Increasing the level of the lake will probably increase the extent and severity of this erosion (ref. Ontario Hydro memo, "Concerns of raising Lake Nipigon minimum level", referenced in Ontario Hydro correspondence, November 20, 1991, E. Boni/B. Lomenda).

Raising the lower limit would be beneficial for the protection of brook trout redds on Lake Nipigon (see Section 4.5).

4.9 SHORELINE EROSION AND PROPERTY DAMAGE

The degree of risk or impact incurred by shoreline property owners depends on their location. The most serious impacts to shore property owners are those associated with erosion and flooding which are most prevalent during storms at higher water levels. Some of the impacts include loss of land and trees, damages to shore protection structures and buildings and loss of use and enjoyment of the shoreline.

Examples of Erosion and Damage

The following are some of the reported cases of shoreline and property damage due to high water levels on Lake Nipigon. This is not a complete inventory of damages and costs. The reported damages, costs and causes have not been verified during this study.

- In 1946, rip rap protection was placed alongside the CNR tracks at Orient Bay in anticipation of the increase in the high water level to elevation 260.6 m (855') (HEPC, 1946 in Wilson, 1991).
- In 1972, Ontario Hydro entered into an agreement with Gull River IR55 for construction and maintenance (until 1992) of 2,740 m (9,000') long section of earth filled embankment with rip rap protection to elevation 262.1 (860') together with a cash payment of $16,500 to compensate for loss of 11 ha (27.2 acres) over 40 years (Day et al., 1982 in Wilson, 1991).
- The Poplar Point Park breakwater/dock/launching ramp required "tens of thousands of dollars" worth of repairs in 1990.
- Breakwater at Rocky Bay Reserve breached 8(see Photograph 3.3.3)
- Shoreline erosion at Rocky Bay Reserve (see Photograph 3.3.2)
- Gull Bay First Nation dock
- Flooded basement and flooded septic tank (3 times in last 6 years, cost to pump out each time is $175.00)
- Damaged docks at Macdiarmid (see Photograph 3.3.7 for example)
- $4,000 to repair damaged dock in Orient Bay.
- $2,000 for materials only to repair shore protection over a period of time on Polly Lake.
- Additional flushing of water plant intakes when turbidity increases.
- Erosion of shoreline along Nipigon River.
- Loss of fishing nets which get tangled up in debris.

Poplar Point Subdivision (taken from MNR draft report, Dec. 1989)

Complaints of shoreline erosion on lots in Plan M279 and Plan M249 at Poplar Point on Lake Nipigon have been made to MNR (see also Photographs 3.3.5 and 3.3.6). In 1980, the Government approved a policy to sell shoreline reserves at cost to the abutting property owner if requested.

Between 1981 and 1983, the land in front of the 15 lots on Lake Nipigon, just south of Poplar Point, were sold to the "regulated" maximum water level of 260.6 m (855.0'). Reports of shoreline erosion on Plan M279 were made to MNR and Ontario Hydro from the beginning of 1984. In 1989, further erosion complaints were brought to the attention of MNR. The owners concerns were twofold: 1) recession of the land diminishes the usable land area; and 2) erosion threatens the foundations of the buildings. Complaints from Poplar Point property owners continue to be heard to the present (B. Hudson, MNR, 1993. pers. comm.).

Based on site visits in September and October of 1989, MNR engineers reported that the soil type in the area of M279 is sandy. Nearshore profiles at Plan M279 showed a very gentle slope and recession of the 260.6 m (855') contour ranged from 1.5 m (5') to 9.1 m (30') over eight years. The profile at M249 was relatively steep and recession rates were much less.

The most severe shoreline recession was 9.1 m (30') over a period of 8 years at Plan M279. The survey pins marking where the 260.6 m (855') contour used to be was now under water at elevations between 259.8 m (852.5') and 260.0 m (853'). Two saunas and a small shed (on lots 11, 10 and 8 respectively) were threatened by the recession of the shoreline. At Lot 8, Plan M279, the sauna had a vertical timber wall protecting its foundation. The owner observed that the beach in front of the wall had gone down about 0.6 m (2') since the completion of the wall.

At Lot 8 Plan M249, the shoreline had receded about 1 m (3') but the former 260.6 m (855') contour was measured as 260.7 m (855.5') (i.e., the beach level was higher).

No definite pattern of erosion was observed. In all cases, shoreline covered by dense vegetation had the least recession.

Shoreline Erosion and Structure Damage

River Bank Erosion

Siltation, resulting from river bank erosion, has effected water quality (increased turbidity) and the bottom substrate in the Nipigon River (R. Swainson, MNR, 1993, pers. comm.). The extent of the degradation of the water quality and bottom substrate is not known.

There is minimal information regarding the effects of the fluctuating river flows on erosion of the banks. While some erosion of a river bank is often a natural occurrence, it seems that it is widely accepted that the many significant flow fluctuations during the year exacerbate erosion of the Nipigon River banks. The extent of the influence of the fluctuations is not known. As well, it is not known how these fluctuations would compare to a single, larger spring freshet flow under natural conditions. In addition, there is no real understanding of how the river channel is adjusting to the increased flow from the Ogoki diversion.

Lake Nipigon Shoreline Erosion

There is no doubt that higher water levels increase the risk of shoreline erosion and structure damage. Shoreline erosion occurs at almost any water level but it is increased at higher water levels. Higher water levels allow the wave action to reach a higher level of the shoreline. Also, the deeper water will result in larger waves being able to reach the shoreline or structure.

The driving force of erosion and damage is primarily wave action superimposed on the water level. In addition to the waves directly attacking the shore, wave energy reflected back from the shore can increase the loss of the beach materials. Reflection is greatest from smooth vertical walls and lowest from rough, porous, gently sloping shores. Sloping stone revetments reflect less wave energy than vertical walls. Other contributing erosive forces are ice action and even surface runoff.

The strength of the shoreline materials provides the resistance to the erosive forces. The resistance is increased by the shoreline vegetation and boulders naturally occurring along the waters edge. Removal of the vegetation and boulders will result in increased erosion.

Damage to structures increases with their age. As the materials deteriorate (i.e., rotting timber cribs) they are more susceptible to being damaged. Some structures are damaged easily due to improper design and/or construction.

The narrowing of beaches during high water levels may not necessarily be erosion but merely an adjustment of the beach profile to the new water level. The profile adjustment is quite common and is natures way of protecting the shoreline. Of course this is of little consolation to users of the beach because the net result is still a narrow beach. The enjoyment of the beach is greater at lower water levels.

Many property and structure owners on Lake Nipigon indicated that the greatest damage to the shoreline takes place when the water level is high and storms occur. The property owners stated that generally the most severe storms happened in September, October and November. Table 4.8.5 gives an indication of how often the daily water level was greater than 260.3 m (854.0') during the months of September, October and November. The water level was greater than 260.3 m (854.0') through September and most of October, 1992.

Table 4.9.1 Percentage of Time in the Fall When the Lake Nipigon Mean Daily Water Level Greater Than 260.3 m (854')

	Percentage of Total Days			
Time Period	September	October	November	Average
1951-60	0.3	0.3	0.7	0.4
1961-70	28.7	21.7	17.7	22.7
1971-80	16.0	6.5	9.7	10.7
1981-90	1.7	10.6	5.7	6.0
1991-92	34.8	35.5	0.0	23.4

From Table 4.9.1, it can be seen that during the most recent two year time period, 1991-92, the water level has been greater than 260.3 m (854.0') for an average 23.4 percent of the time during the "stormy" period of September to November. During the previous four decades, the average time varied from 0.4 percent to 22.7 percent. While the average for 1991-92 has been higher than in the past, it only represents a two year time period and it is similar to the average for the 1960's.

4.10 LANDSLIDES

Small localized slides, which do not have a significant impact on water quality, are common on the Nipigon River (RAP, 1991). New landslides have occurred recently in the vicinity of the railway line and the Hydro transmission line (R. Swainson, MNR, 1993, pers. comm.). In RAP (1991) it was stated that it is not known whether deposition of sediments is a significant factor in habitat loss, but, given the magnitude of recent landslides, this issues warrants consideration.

On April 23. 1990, a landslide occurred on the east bank of the Nipigon River about 8 km south of the Alexander GS. The failure extended about 350 m inshore and had a maximum width of about 285 m. The failed mass slumped into the river. Heavy siltation affected the fish spawning beds and forced the relocation of the Town of Nipigon water intake. The Town of Nipigon looked to Ontario Hydro for compensation for the $122,000 cost of relocating the intake from the River to the lagoon.

A geotechnical investigation of the landslide, including seven boreholes, was carried out by Trow (1990) for Trans Canada Pipelines and MNR. Trow "concluded that this retrogressive type landslide was caused by a number of naturally occurring and man caused factors. These were: high soil moisture conditions in the area due to sudden thaw; weak and sensitive soils of glacial lacustrine origin; and toe erosion of slopes by the river flow. The man caused factors were: tree harvesting in the watershed of the failed area; cleared right-of-way; and altered drainage pattern by the gas

pipeline and rapid fluctuations of the river by Alexander GS operation. On the basis of this study, they cautioned against further tree harvesting in the areas of lacustrine deposits and the rapid draw down of the river levels. They also recommended further engineering studies into seasonal variations of groundwater conditions and to set up guidelines for acceptable river level draw down and their timing to prevent bank failures of this nature" (Ontario Hydro memorandum, Feb. 25, 1991).

In July, 1991, three additional boreholes were put down in the vicinity of the landslide by Ontario Hydro. Radhakrishna *et al.* (1992) completed an analysis of the landslide. The Nipigon River is apparently in the early stages of flood plain development. The lacustrine sediments are susceptible to slope failures and erosion. Steep slopes tend to develop on the outside bank of bends in the river. By comparing aerial photographs, Radhakrishna *et al.* (1992) estimated that single event slump failures have occurred along 79 percent of the shoreline between Alexander GS and Lake Helen. The most persistent and rapid erosion takes place on the outside bends. Thirty-one sites of retrogressive failures were tentatively identified. Twelve of these were dated between 1931 and 1978 and two from 1979 to 1991. The remaining seventeen occurred prior to 1931, many of them prior to this century.

Radhakrishna *et al.* (1992) postulated that the failure was initiated by an initial slide of the bank slope and a subsequent retrogressive failure of the land behind the bank slope. They reported the following:

> "...the 1990 failure site had most of the characteristics that were present at other retrogressive failure sites.
>
> "Even though the river drawdown event had an effect on the slope stability of the bank, it alone could not have caused the 1990 initial failure, because the slopes in this area had experienced drawdown events of similar magnitude several times without any major slope instability. In addition, the failure occurred 5 days after the drawdown event. Therefore, additional factors must have existed for the failure to occur."
>
> "Based on the results of the parametric analysis of the initial bank failure, the following factors are ranked to be the most critical ones in the following order: i) High groundwater pressure regime existed in the site prior to failure, ii) loss of soil suction in the bank slope above the phreatic surface due to surface infiltration from rapid ground thaw, iii) weak shear strength of the clayey silt deposit, iv) steepening of submerged slope by erosion, and v) lower river levels.
>
> "The high groundwater conditions and the loss of suction were both related to the rapid thawing of the ground and high infiltration of snow melt water in the partly clear-cut watershed area. The scour and drawdown conditions also existed at this failure site.
>
> "The retrogressive failure was the result of the combined action of high pore pressures in the sandy silt layer and susceptibility for liquefaction of silt predominated soft lacustrine deposits in the area."

4.11 LOGGING

The 1911 Annual Report of Game and Fisheries (cited in Wilson, 1991) said that it was feared that timber may be brought to Lake Superior via the Nipigon River thus destroying the river as a "trout stream".

> "the stream is now looked upon as a national stream, and it is felt that it would be a crime indeed to spoil this stream by the running of logs and pulp wood down the river."

> "log driving down the river would immeasurable depreciate, even irretrievably ruin, the trout fisheries" (Ontario Game and Fisheries Commission, 1912 in Wilson, 1991)

Habitat degraded by historic logging practices is an immediate concern (RAP, 1991). Accumulations of bark and wood fibre may effect aquatic organisms. In addition to causing changes in fish habitat, scouring by log drives and accumulations of woody material have reduced the diversity of benthos (RAP, 1991).

Use of the Nipigon for running logs was stopped in the early 1970's.

4.12 OTHER ISSUES

4.12.1 Ogoki Diversion

The study should include a review of the Ogoki diversion. It has increased the flows in the Nipigon River by about 50 percent. Reports of significant siltation resulting from the diversion are of significant concern to many stakeholders on Lake Nipigon.

An Ontario Hydro study (Near, 1982, cited in Wilson, 1991) reported that as a result of the Ogoki diversion, the Little Jackfish River changes from a minor stream to an excavated soft wide channel. It recognized the need for channel improvements due to slope instability, scouring and undermining of silts and fine particles. Holmes (1975, cited in Wilson, 1991) estimated that approximately 30 million cubic yards of sediment was released from the Little Jackfish River between 1943 and 1972 due the increased flow from the Ogoki Diversion. In 1976, Holmes (1976, cited in Wilson, 1991) reported that sediment deposits in Ombabika Bay, near the mouth of the Little Jackfish River, since 1943 were about 9 m (30') in depth. Holmes further concluded that the increased sediment deposition in Ombabika Bay does not limit the bottom organisms to the extent that the balance of the food chain is disrupted. He did find however that there was an increase in the sauger to walleye ratio in Ombabika Bay.

4.12.2 Shoreline Clearing

At this point in the study, the issue of clearing of the shoreline (as required by License of Occupation No. 2585), prior to raising the maximum level of Lake Nipigon to 260.6 m (855.0') (as authorized by License of Occupation No. 7785), has not been resolved. According to a MNR North Central Region memorandum (December 19, 1989; re: draft report Shoreline Erosion Study, Poplar Point Area on Lake Nipigon) the required clearing around the Lake Nipigon shoreline, as specified by License of Occupation No. 2585, was carried out during the 1940's. However, the study team was told by some of the Lake Nipigon stakeholders that the required clearing was never carried out. They are seriously concerned about elevated levels of methylated mercury in the pure waters of Lake Nipigon. Mercury levels can increase when trees along flooded shorelines decompose.

4.13 SUMMARY OF CONFLICTS

The conflicts can be summarized broadly as follows:

1) Users on the Nipigon River, including the fisheries, those users associated with the fisheries (including the wildlife which depend on the fish), First Nations, and shore property owners, want the river flows stabilized and kept above a specified minimum flow rate and below a specified maximum flow. Restricting the flows reduces the flexibility of Ontario Hydro to optimize their hydro-electric output and likely will increase the range of water levels on Lake Nipigon.

2) Users on Lake Nipigon, including the fisheries, those user associated with the fisheries (including the wildlife which depend on the fish), First Nations, shore property owners, charter operators, and tourism interests want the lake level range to be decreased and kept above a specified minimum level and below a specified maximum. Restricting the range of levels on the lake also reduces the flexibility of Ontario Hydro to optimize their hydro-electric output and may result in greater river flow fluctuations.

3) Ontario Hydro wants the flexibility to fluctuate the river flows to meet peak energy demands and to operate within the widest possible range of levels on the lake, within reason, in order to provide an efficient, reliable source of power. This conflicts with what many of the lake and river users want.

The broad conflicts can then be expanded into more specific conflicts between the various users on the lake and river. For example, while property owners and charter operators both want a reduced range of lake levels, they differ with respect to how big the range should be, what are the lower and upper limits and at what times of year are most important.

Figures 4.13.1 and 4.13.2 provide a summary of the conflicts on the Nipigon River and Lake Nipigon respectively. These figures are not final. They will be expanded as more information becomes available.

SUMMARY OF CONFLICT AT NIPIGON RIVER

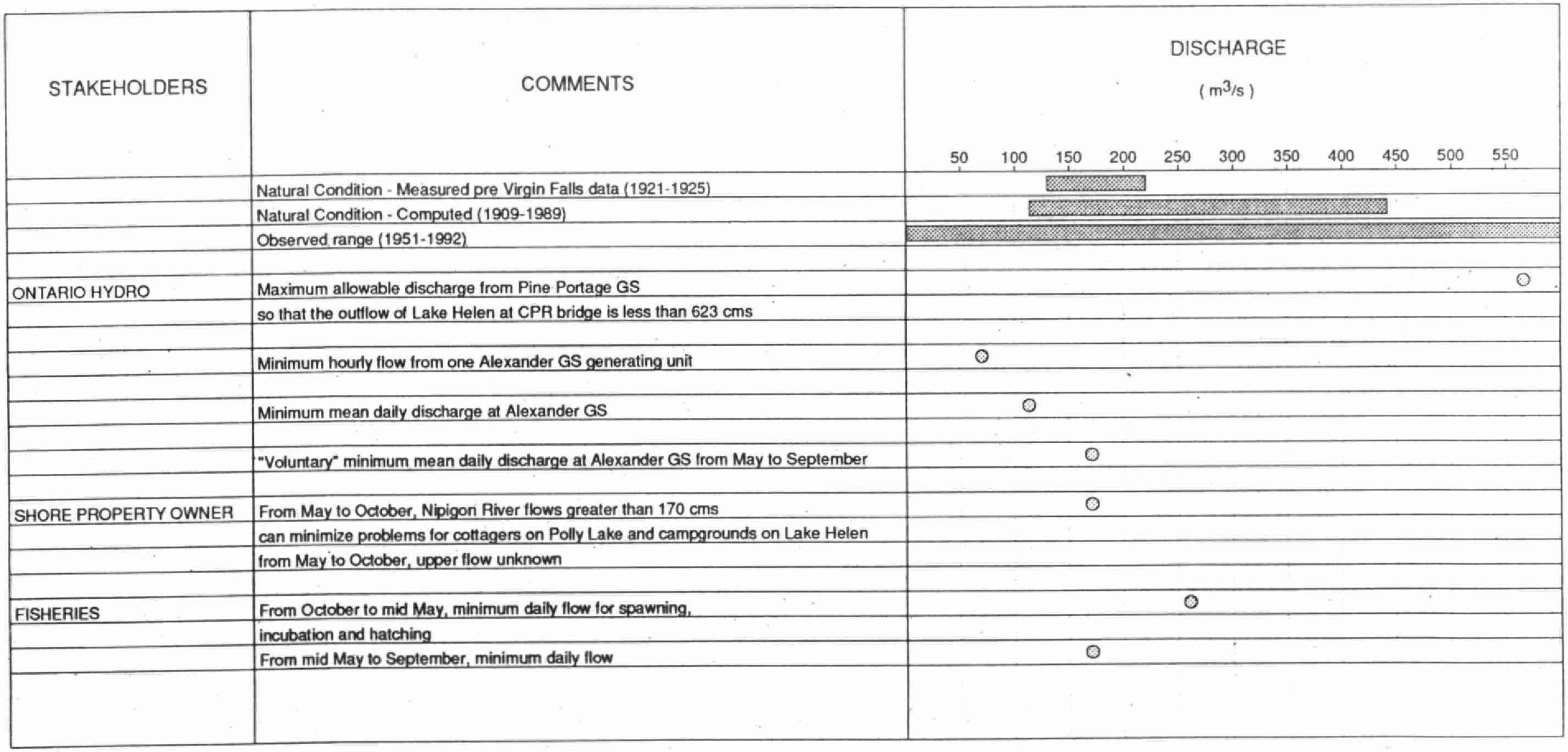


Figure 4.13.1 **Summary of conflict at Nipigon River**

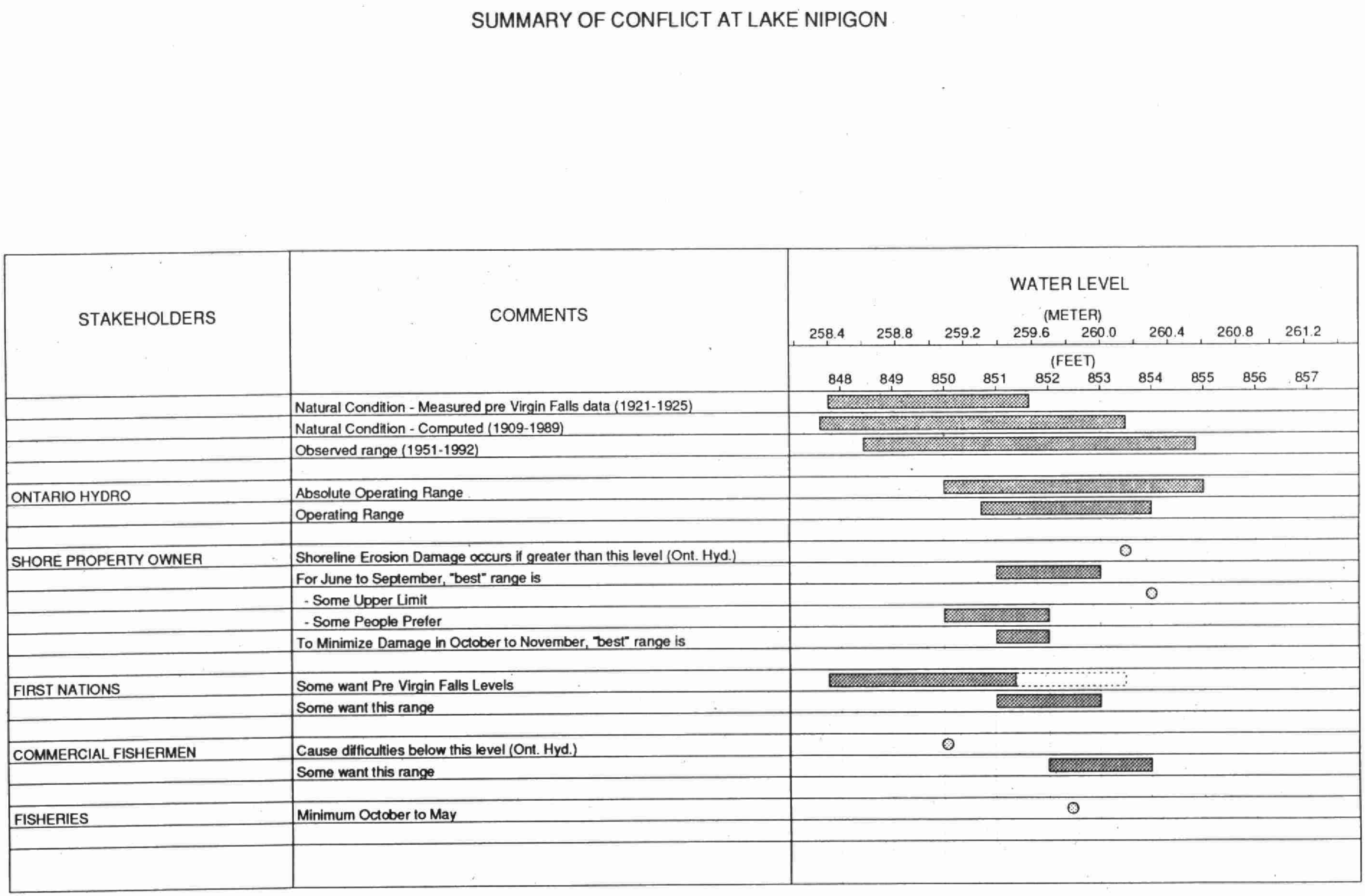


Figure 4.13.2 Summary of conflict at Lake Nipigon

5.0 PRELIMINARY OPTIONS

Given the goal of the project, the needs of the different users and the available information, and giving preliminary consideration to resolving the conflicts, the following five management options were identified:

Option A

At all times, the flow rates in Nipigon River below the Alexander Generating Station would be greater than 260 m^3/s from October to May 15 and greater than 170 m^3/s from May 15 to September.

Option B

At all times, the flow rates in Nipigon River below the Alexander Generating Station would be greater than 260 m^3/s from October to May 15 and greater than 170 m^3/s from May 15 to September with a restriction on reducing flow levels to stabilize the fluctuations.

Option C

The average daily flow rate in the Nipigon River below the Alexander Generating Station would be greater than 270 m^3/s in October and greater than 170 m^3/s from November to September with peaking restricted to stabilize the fluctuations.

Option D

Reduce the range of water levels on Lake Nipigon by decreasing the upper operating limit by 0.3 m (1 foot).

Option E

Reduce the range of water levels on Lake Nipigon by increasing the lower operating limit by 0.3 m (1 foot) and decreasing the upper operating limit by 0.15 m (0.5 foot).

The options are presented in Table 5.1. Each of the options is briefly described along with a qualitative assessment of the potential benefits and costs (i.e., pros and cons).

These preliminary five options are not necessarily the only options that will be considered. In the course of evaluating the preliminary options, other options may be identified for consideration. These may be totally new options or variations of the original options.

Evaluation of the options is described in Chapter 6.

Table 5.1 Preliminary water quantity management options for the Nipigon River and Lake Nipigon

OPTION	BENEFITS	COSTS	COMMENTS
A. Maintain minimum instantaneous Nipigon River flow, below Alexander GS: ≥ 260 m^3/s October 1 to May 15 ≥ 170 m^3/s May 16 to September 30	-Protects brook trout redds on river during critical period for spawning, incubation and hatching -Increases protection to river benthos and habitat -Reduces range and frequency of river fluctuations -Reduces erosion of river banks -Improves use and enjoyment of shore property owners on Lake Helen and Polly Lake with respect to fluctuations	-Ontario Hydro's ability to meet peak demand is reduced (i.e., peaking capacity very restricted) -Range of the water levels on Lake Nipigon probably increase, especially a decrease in the lower limit	-Minimum instantaneous flow restriction same as existing interim agreement between Nipigon MNR and Ontario Hydro -MNR prefers 300 m^3/s mid-Oct. to mid-Nov. for spawning -Shore property owners on Lake Helen and Polly Lake would still be concerned about erosion and fluctuations in water level if no upper limits placed on flows and no controls on peaking -Possibly use storage on Jessie Lake, between Pine Portage GS and Cameron Falls GS, to absorb the peaking at Pine Portage GS - This may cause destruction of fish habitat on Jessie Lake

Table 5.1 Preliminary water quantity management options for the Nipigon River and Lake Nipigon

OPTION	BENEFITS	COSTS	COMMENTS
B. Maintain minimum instantaneous Nipigon River flow, below Alexander GS: ≥ 260 m^3/s October 1 to May 15 ≥ 170 m^3/s May 16 to September 30 **and restrict peaking** (flow reduction only, no restriction on increase) -maximum reduction 100 m^3/s in 24 hrs -maximum reduction in single event is 50 m^3/s & minimum 4 hrs between events -24 hr period begins with first reduction	-Protects brook trout redds on river during critical period for spawning, incubation and hatching -Less rapid dewatering of river during peaking -Further increases protection to benthos and habitat -Reduces range and frequency of river fluctuations -Further improves use and enjoyment of shore property owners on Lake Helen and Polly Lake with respect to fluctuations (compared to Option B.)	-Ontario Hydro's ability to meet peak demand reduced (i.e., peaking capacity further restricted) -Range of the water levels on Lake Nipigon probably increase, especially a decrease in the lower limit	-Peaking restriction same as existing restriction which was imposed following April, 1990 landslide -Shore property owners on Lake Helen and Polly Lake would still be concerned about erosion and fluctuations in water level if no upper limits placed on flows -Possibly use storage on Jessie Lake, between Pine Portage GS and Cameron Falls GS, to absorb the peaking at Pine Portage GS - This may cause destruction of fish habitat on Jessie Lake
C. Maintain minimum average daily Nipigon River flow, below Alexander GS: ≥ 260 m^3/s October ≥ 170 m^3/s November to September **and restrict peaking** -decay event ≤ 24 hrs -minimum hourly flow ≥ 113 m^3/s -no peaking in October -lower peaking flows ≥ 260 m^3/s in spring (likely late April - early May)	-Improves Ontario Hydro's ability to provide dependable energy production (i.e., increased flexibility to meet contingencies and more peaking ability) -Provides protection to river brook trout at spawning time only	-Brook trout redds on river only partially protected during critical incubation and hatching time -Some increase in adverse effects to river benthos and habitat -River bank erosion continues -Lake Helen and Polly Lake shore property owners still affected by fluctuations and high flow -Will affect range of water levels on Lake Nipigon (i.e., a spring decline in flow, to offset possible low Lake Nipigon levels, would not be permitted below 260 m^3/s)	-Based on proposed option by Pope and Metcalfe (1991, draft) -Possibly consider weir control structure, at Polly Lake outlet to Lake Helen, to improve fluctuations on Polly Lake

Table 5.1 Preliminary water quantity management options for the Nipigon River and Lake Nipigon

OPTION	BENEFITS	COSTS	COMMENTS
D. Reduce range of water levels of Lake Nipigon by decreasing upper limit 0.3 m (1'): -operating 259.3 m to 260.0 m (850.8' to 853.0') -absolute 259.1 m to 260.3 m (850.1' to 854.0')	-Lake Nipigon shore property owners subject to less erosion and structure damage -Lake Nipigon tourism, beachcombing attractions improve because lake shoreline less frequently submerged -Lake Nipigon shore erosion reduced -less debris and trees into water	-Reducing range decreases storage capacity of Lake Nipigon -therefore in periods of high inflow, higher discharges down the river will be required (increased erosion, risk to railroad bridges at Nipigon) and in periods of lower inflows, lower discharges down the river will be necessary -Low flow on river may not be able to meet minimum flow requirement for protection of brook trout spawning on river -Greater impact to Lake Helen and Polly Lake due to increased range of river flows -Dependable production of hydro-electric power decreased	-May need to address restrictions on when Ogoki diversion flow is reduced and then stopped -Possibly consider weir control structure, at Polly Lake outlet to Lake Helen, to improve fluctuations on Polly Lake -Lake Nipigon fluctuations, similar to range and timing of "natural" pattern, are beneficial to Lake Nipigon ecosystem - reduction in fluctuations may have adverse impact

Table 5.1 Preliminary water quantity management options for the Nipigon River and Lake Nipigon

OPTION	BENEFITS	COSTS	COMMENTS
E. Reduce range of water levels of Lake Nipigon by increasing the lower limit by 0.3 m (1') and small decrease in upper limit of 0.15 m (0.5'): -operating 259.6 m to 260.15 m (851.8' to 853.5') -absolute 259.4 m to 260.45 m (851.1' to 854.5')	-Lake Nipigon brook trout spawning shoals better protected -Navigation improved on Lake Nipigon -Shore property owners on Lake Nipigon subject to a little less erosion and structure damage -Lake Nipigon shoreline beaches exposed more frequently for tourism, beachcombing -Lake Nipigon shore erosion reduced -less debris and trees into water	-Reducing range decreases storage capacity of lake -therefore in periods of high inflow, higher discharges down the river will be required (increased erosion, risk to railroad bridges at Nipigon) - and in periods of lower inflows, lower discharges down the river will be necessary -Low flow on river may not be able to meet minimum flow requirement for protection of brook trout spawning on river -Greater impact to Lake Helen and Polly Lake due to increased range of river flows -Dependable production of hydro-electric power decreased	-Upper limit of Lake Nipigon reduced to account for storm surge wave action -May need to address restrictions regarding when Ogoki diversion flow is reduced and then stopped -Possibly consider weir control structure, at Polly Lake outlet to Lake Helen, to improve fluctuations on Polly Lake -Lake Nipigon fluctuations, similar to range and timing of "natural" pattern, are beneficial to Lake Nipigon ecosystem - reduction in fluctuations may have adverse impact

6.0 EVALUATION OF OPTIONS

General

The options will be evaluated during the second year of the study. The options will be presented for general public discussion at combined open houses/public meetings and then be the subject of discussion by the community. It is the goal of the evaluation phase of the study to come to a community consensus on a preferred management option and implementation process.

Once the public has had an opportunity to comment on the options, each will be evaluated using a Multi-Objective Optimization Model. This model will provide a way to quantify competing interests so that an optimal operating option, which represents a reasonable compromise to all the stakeholders, can be identified. An important first step is to assign a relative weight or emphasis to each of the benefits and costs.

Through the second year of the study, the options will be evaluated with the help of a community-based Nipigon River Water Quantity Management Working Group. The working group will assist in determining the weights applied to each of the benefits and costs and will be involved in the modelling exercise.

All working group meetings are open to the public. Terms of Reference for this working group are in Appendix 1A

Multi-objective Optimization Modelling

As noted earlier, the study is utilizing a multi-objective optimization model for management of the Nipigon River water flows and Lake Nipigon levels. This model incorporates social and environmental objectives into the management procedures. The multi-objective optimization model that will be used for Nipigon is introduced in this section and further outlined in Appendix 6A.

Identification of an optimal strategy for the Nipigon River system is made more complicated due to the competing economical and environmental interests. The stakeholders in this study have been identified in Chapter 2. These various interests can be mutually exclusive in that what is good for one stakeholder is bad for one or more of the others. For example, hydro power generations may be most efficient when seasonal storage in Lake Nipigon is maximized by allowing the levels to vary over a wide range. The extreme high and low levels pose inconvenience or danger to other interest groups such as lakeshore property owners (who prefer an average level throughout the year), fish spawning redds (which must remain covered) and boat operators (who suffer losses if level are too low).

The purpose of the model is to provide a methodology whereby these competing interests can be quantified in manner which allows an optimal operating strategy to be identified which represents a reasonable compromise to all the stakeholders.

The optimal strategy will take the form of a suggested sequence of values of discharge and water level which should be maintained in order to achieve this compromise.

Optimization involves the comparison of a very large number of feasible alternatives for which an objective function is evaluated. This is simply a measure of the total benefits and costs to all of the stakeholders who are affected by the control of flows and levels in the lake and river system. Ideally, all of the costs or benefits should be expressed in terms of a dollar value so that they can be added together. Unfortunately, many of the interests involve somewhat intangible costs or benefits which makes simple addition impracticable unless certain assumptions are made.

The assumptions required involve placing some relative weight or emphasis on the cost or benefit to the different interest groups and experimenting with different weights to see how these affect the best or optimal strategy.

The process of computer modelling involves two stages:

(1) The first stage defines the penalty functions for each group of stakeholders and allows the user to sum these together in some realistic way with relative weights that can be varied easily. The resulting composite penalty terms are written to a computer interface file which links the two stages of the analysis together.

(2) The second stage starts by reading the data from the interface file. The composite penalty terms are then used as an objective function which is to be minimized by manipulating the levels and flowrates at various discrete locations over different time periods. The optimal strategy is determined by a network analysis program which is a variation of linear programming.

Each of these stages is discussed in more detailed in Appendix 6A.

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APPENDICES

NIPIGON RIVER

DEVELOPMENT OF A WATER MANAGEMENT PLAN

DRAFT OPTIONS REPORT

Appendix 1A

Draft Terms of Reference - Nipigon River Water Quantity Management Working Group

DRAFT TERMS OF REFERENCE
NIPIGON RIVER
WATER QUANTITY MANAGEMENT WORKING GROUP

Background

Atria Engineering has been contracted by the Nipigon River Management Committee (which includes representatives from the Ontario Ministries of Natural Resources and Environment and Energy, Ontario Hydro, the Nipigon Remedial Action Plan RAP Team and Public Advisory Committee) to establish - with as high a degree of community consensus, as possible - a preferred option for managing water quantities in the Nipigon River.

In the first year, stakeholders in the Nipigon River, Lake Nipigon and Lake Helen region were interviewed. Some stakeholders living outside the region, but who use the river, were also interviewed. As well, all available data was collected.

A report which outlines the uses and conflicts, stakeholder concerns and a preliminary set of management options will be released in May, 1993. All those interviewed, as well as other interested parties will receive a copy of the report.

The report is to be the subject of three public meetings to be held on June 8, 9 and 10, 1993.

In this, the second year of the project, a preferred water quantity management option for the Nipigon River will be determined.

The Nipigon River Water Quantity Management Working Group

Atria Engineering is establishing the Nipigon River Water Fluctuations Working Group - a community-based working group - to assist in the selection of the preferred option.

The preferred option will be determined in consultation with the working group. A draft final report detailing the preferred option will be released for community review before it is finalized and submitted to the Nipigon River Management Committee by the end of March, 1994.

Objectives of the Water Quantity Management Working Group

The objectives of the working group are to:

1. review with Atria the comments received during the public meetings in June as well as any written comments that are submitted;

2. represent the range of community interests and concerns in the work leading to the selection of a preferred option;

3. provide a forum for non-members to present their views and options; and

4. assist Atria in developing a consultation program for the review of the preferred option by the wider community.

Steps in the Planning Process

The preferred option will be selected through:

1. narrowing the list of potential options to a list of the most feasible options;

2. determining the selection criteria for the preferred option;

3. conducting in-depth research on the environmental and cost/benefit of the feasible options;

4. applying the selection criteria; and

5. considering comments during a consultation program made on the preferred option.

Membership

Atria Engineering	(2 members, including the chair)
Environmental Groups	(1 member)
Nipigon RAP Public Advisory Committee	(1 member)
Fish and Game Clubs	(2 members)
Municipal Governments	(2 members)
First Nations	(2 members)
MNR's Nipigon Advisory Committee	(1 member)
Charter Boat Operators	(1 member)
Cottagers	(2 members)
Commercial Fishing Operators	(1 member)
Tourist Operators	(1 member)
General Public	(2 members)

Note: The working group may decide to assign additional members to represent the categories identified above at its first meeting.

The Nipigon River Water Quantity Management Committee will have observer status.

Members will be asked to:

- review the comments made during the consultation on the first report;
- make recommendations on a "most feasible options" list;
- review and comment on all research done on the feasible options list;
- help plan any public information or consultation activity;
- review and comment on the preferred option report;
- review the comments made during the preferred option consultation; and
- work to develop a consensus on a preferred option.

Members do not have to represent any position other than their own. However, they must be prepared to consider differing positions of others.

Members may send an alternate to any meeting if they are unable to attend a meeting. The alternate can vote as a regular member. The alternate will be responsible for briefing the regular member on what happened at the meeting.

Operating Rules:

Atria Engineering will chair the Nipigon River Water Quantity Management Working Group.

The working group will meet six times.

The first meeting of the working group will be on Thursday, June 24, 1993 in Nipigon from 7:00 p.m. - 9:30 p.m. The location and time for all other meetings (which will begin in September and run through January 1994) will be determined by the members of the working group.

Minutes of all meetings will be taken and distributed to working group members within two weeks prior to the next meeting.

Information required by the group will be provided in a timely manner.

Previous decisions made by the working group can be raised for reconsideration. Any member requesting that a decision be reconsidered will provide a written rationale to the chair for distribution to all other members.

All working group meetings will be open to the public. Each agenda will allow for non-members to express their opinions. Those wishing to make a formal presentation to the working group will be required to notify the chair that they wish to make a presentation to the group.

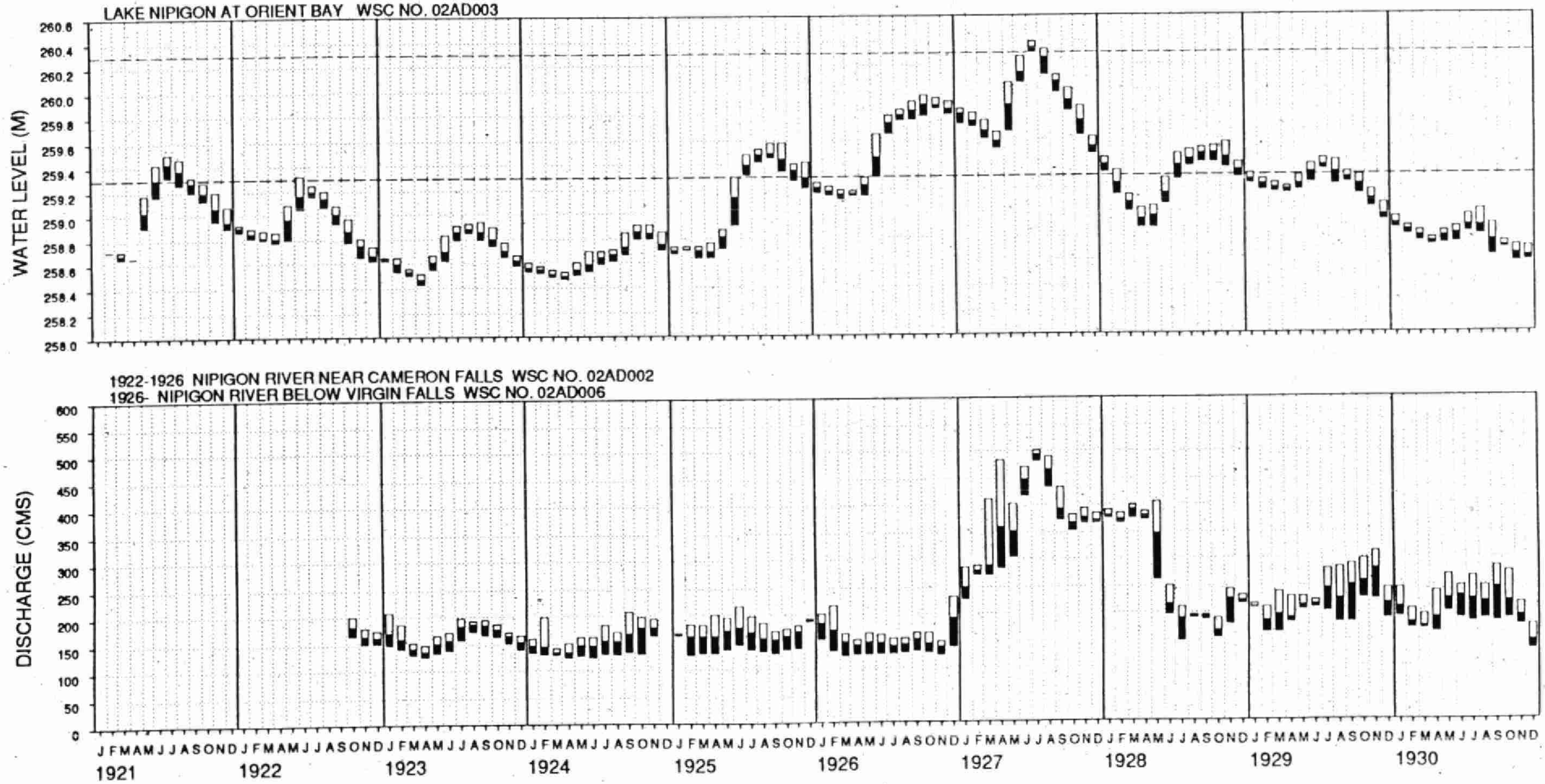
It will be chair's responsibility to ensure the smooth running of working group meetings and that all members have an opportunity to contribute to the discussion. The chair also will be responsible for working with the group in trying to reach a consensus on a preferred option.

If you are interested in becoming a member of the working group, or wish to recommend someone we should contact about becoming a member, please telephone (call collect) Mark Kolberg of Atria Engineering at (416) 891-0020.

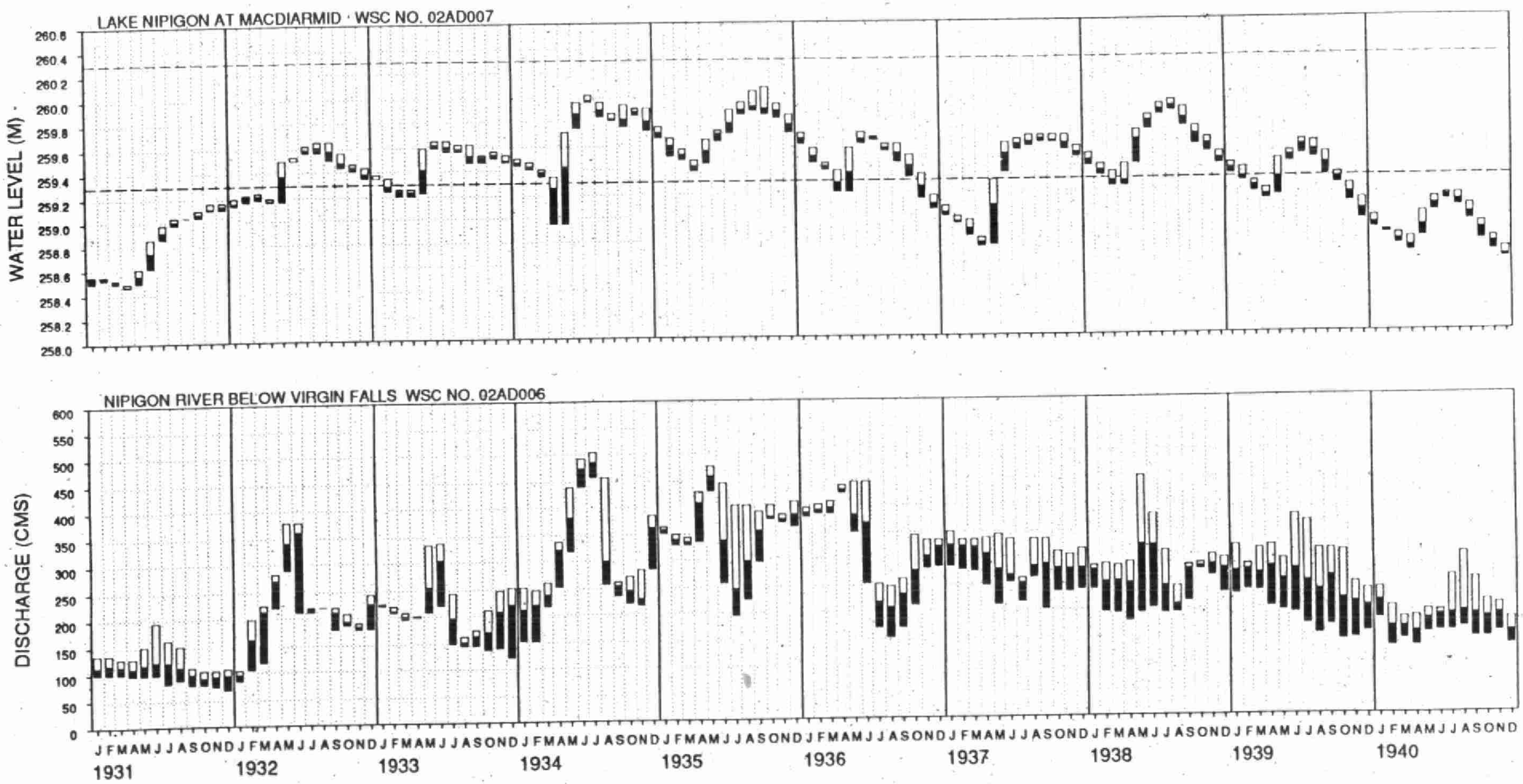
Appendix 2A

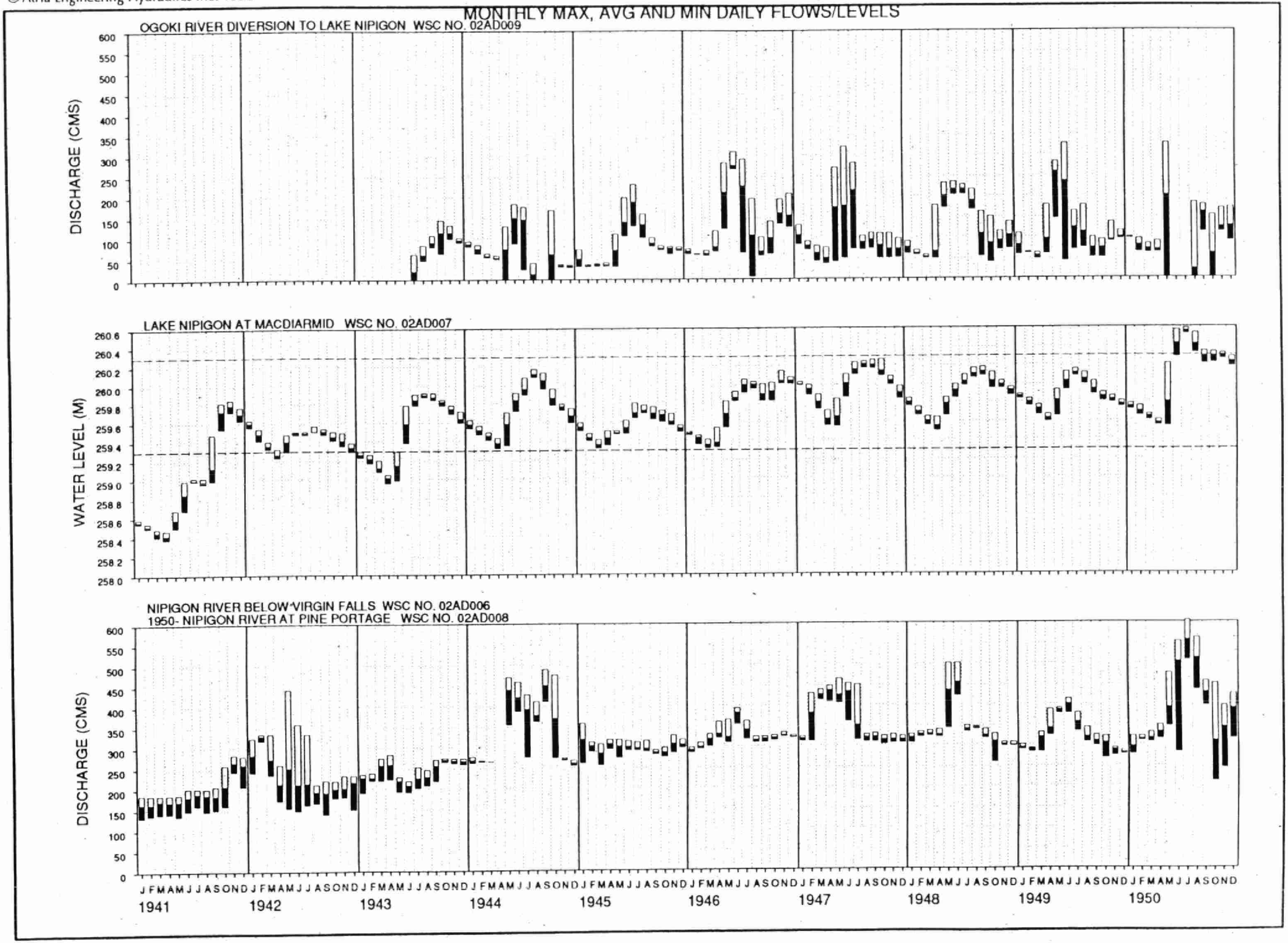
Recorded Discharges Ogoki Diversion, 1943 - 1990
Recorded Levels Lake Nipigon, 1921 - 1990
Recorded Discharges Nipigon River, 1922 - 1990

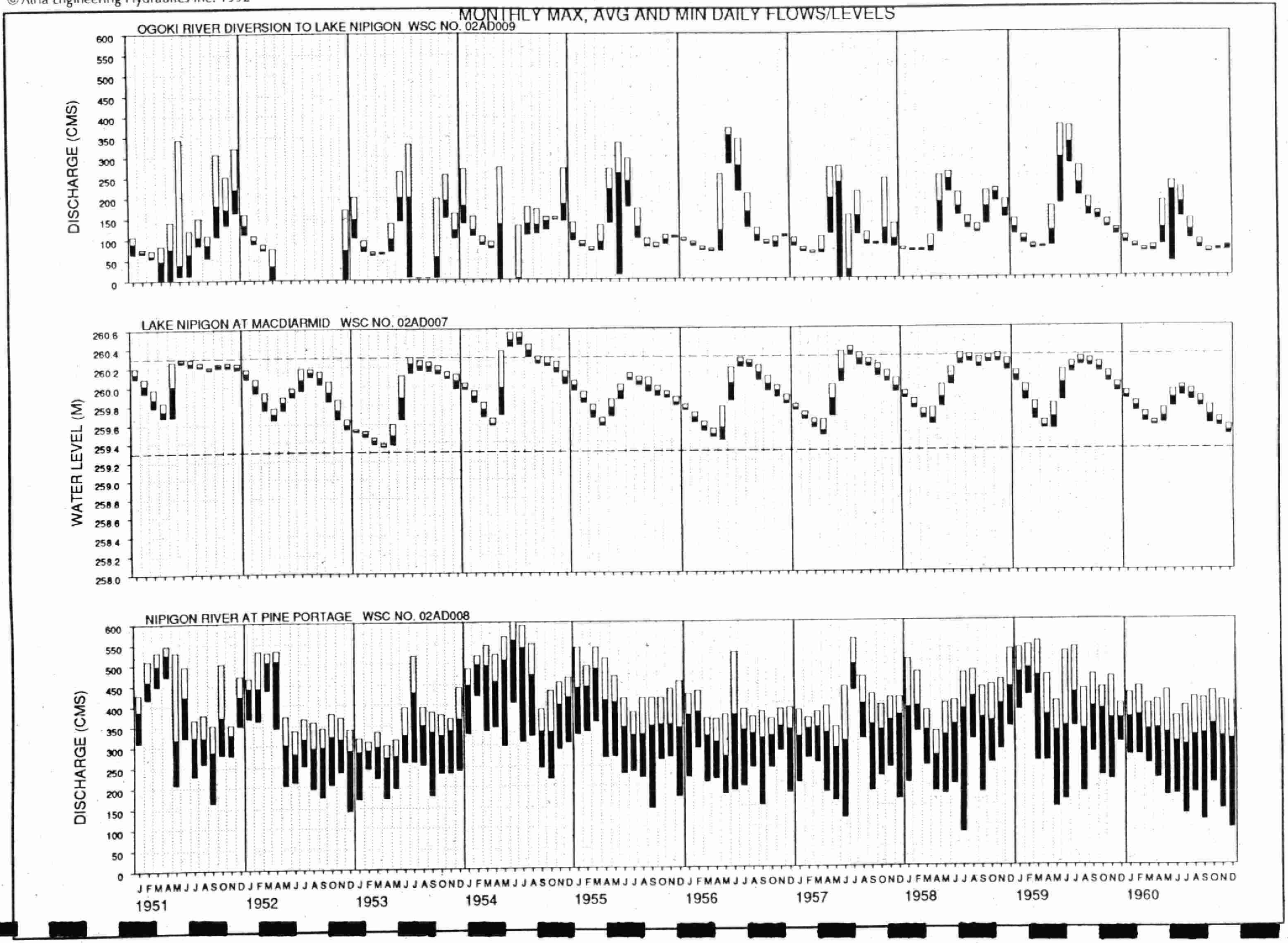
MONTHLY MAX, AVG AND MIN DAILY FLOWS/LEVELS



MONTHLY MAX, AVG AND MIN DAILY FLOWS/LEVELS




MONTHLY MAX, AVG AND MIN DAILY FLOWS/LEVELS
OGOKI RIVER DIVERSION TO LAKE NIPIGON WSC NO. 02AD009
DISCHARGE (CMS)
LAKE NIPIGON AT MACDIARMID WSC NO. 02AD007
WATER LEVEL (M)
NIPIGON RIVER BELOW VIRGIN FALLS WSC NO. 02AD006
1950- NIPIGON RIVER AT PINE PORTAGE WSC NO. 02AD008
DISCHARGE (CMS)
J F M A M J J A S O N D
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950



MONTHLY MAX, AVG AND MIN DAILY FLOWS/LEVELS
OGOKI RIVER DIVERSION TO LAKE NIPIGON WSC NO. 02AD009
DISCHARGE (CMS)
LAKE NIPIGON AT MACDIARMID WSC NO. 02AD007
WATER LEVEL (M)
NIPIGON RIVER AT PINE PORTAGE WSC NO. 02AD008
DISCHARGE (CMS)
J F M A M J J A S O N D
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1953
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1958
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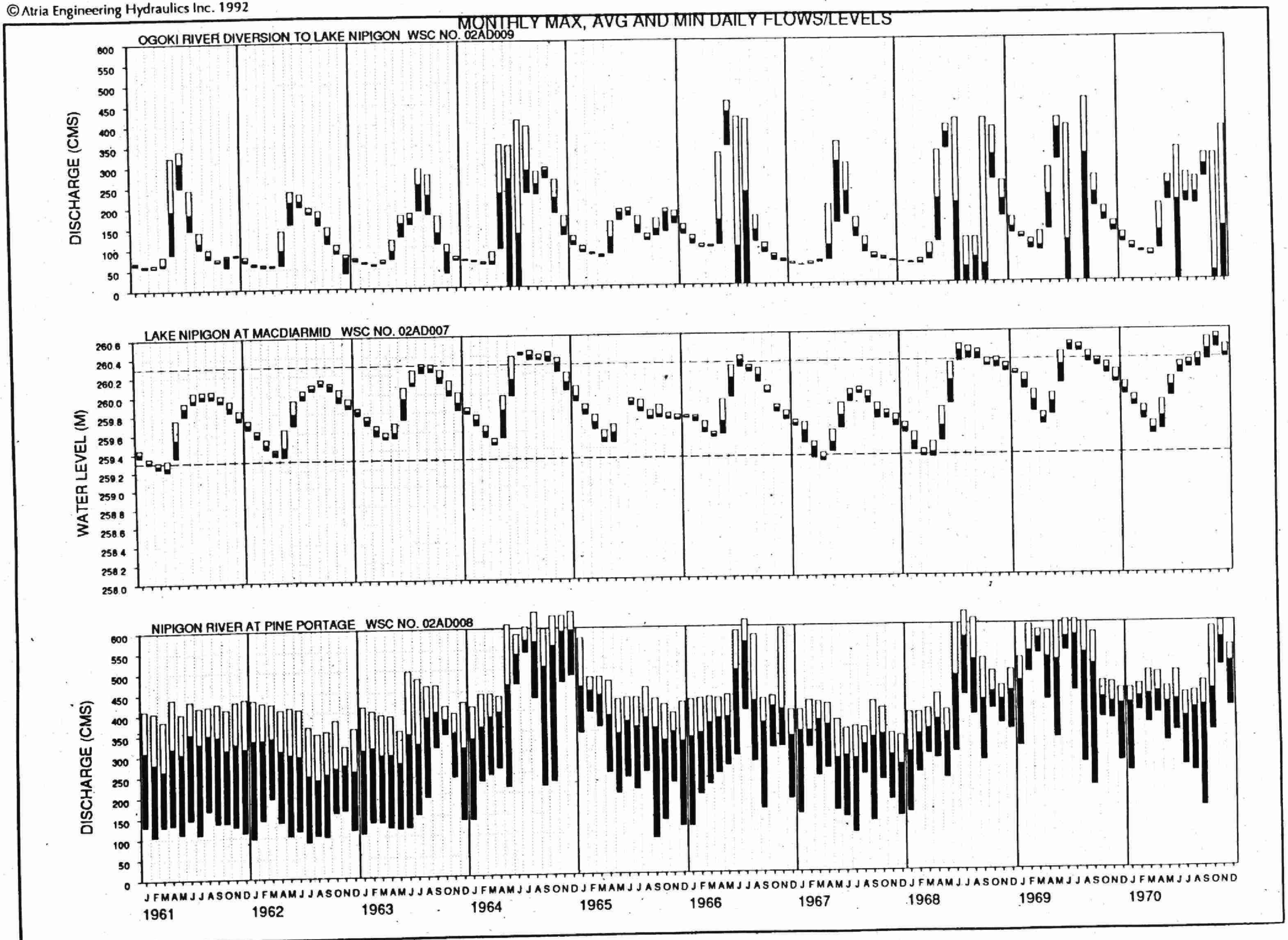
1960


MONTHLY MAX, AVG AND MIN DAILY FLOWS/LEVELS
OGOKI RIVER DIVERSION TO LAKE NIPIGON WSC NO. 02AD009
DISCHARGE (CMS)
LAKE NIPIGON AT MACDIARMID WSC NO. 02AD007
WATER LEVEL (M)
NIPIGON RIVER AT PINE PORTAGE WSC NO. 02AD008
DISCHARGE (CMS)
1961
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1963
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1967
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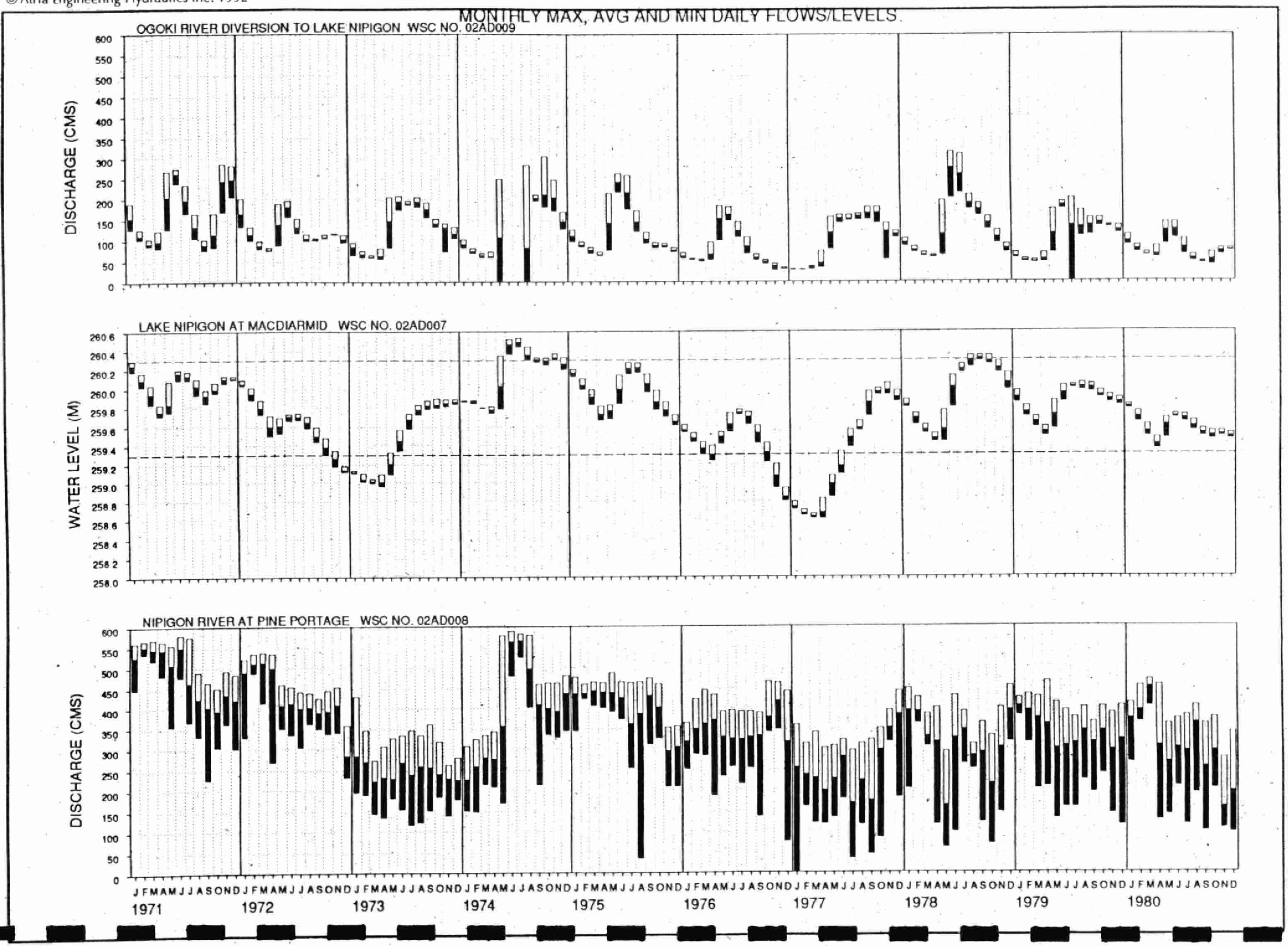
1970


MONTHLY MAX, AVG AND MIN DAILY FLOWS/LEVELS
OGOKI RIVER DIVERSION TO LAKE NIPIGON WSC NO. 02AD009
DISCHARGE (CMS)
LAKE NIPIGON AT MACDIARMID WSC NO. 02AD007
WATER LEVEL (M)
NIPIGON RIVER AT PINE PORTAGE WSC NO. 02AD008
DISCHARGE (CMS)
J F M A M J J A S O N D
1971
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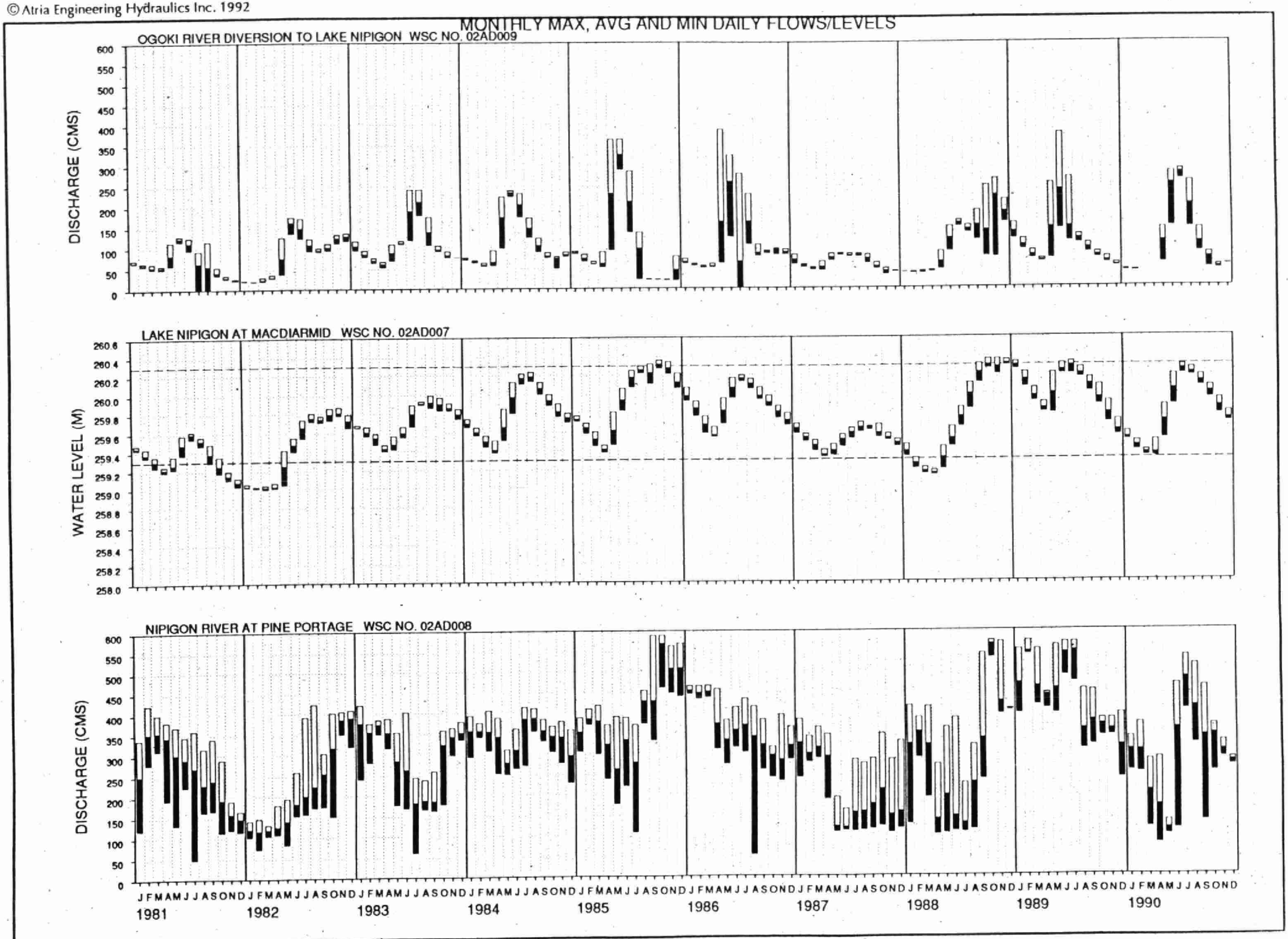
MONTHLY MAX, AVG AND MIN DAILY FLOWS/LEVELS
OGOKI RIVER DIVERSION TO LAKE NIPIGON WSC NO. 02AD009
DISCHARGE (CMS)
LAKE NIPIGON AT MACDIARMID WSC NO. 02AD007
WATER LEVEL (M)
NIPIGON RIVER AT PINE PORTAGE WSC NO. 02AD008
DISCHARGE (CMS)
J F M A M J J A S O N D
1981
1982
1983
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1985
1986
1987
1988
1989
1990

Appendix 2A.1

Origin and Identified Requirement of Cameron Falls Generation Station

Origin and Identified Requirement of Cameron Falls Generating Station

Extracted From "Report of the Hydro-Electric Power Commission of Ontario"

The following, is an account of when and how the need for additional generating resources arose in the Nipigon and Thunder Bay districts.

The Hydro - Electric Power Commission of Ontario recognised the rapid rate of load growth in the above mentioned areas as early as 1916. The majority of power at the time was being supplied from both the Kaministiquia Power Company and the Commissions Current River Hydraulic Plant located in the city of Port Arthur (total load = aprox. 5,000 hp.). All indications pointed toward the need for more power in the very near future due to industrial undertakings and business expansion.

In 1917 a survey of the industrial prospects in this vicinity was taken. It was estimated that the peak load demand of the City of Port Arthur would amount to approximately 10,000 hp. within the next few years. During this year the Commission proceeded with upgrades to their 22 KV supply to the four existing grain elevators.

Also, on January 1, 1917 a vote by the Port Arthur ratepayers (712 for to 22 against) created a new power agreement with the Commission. The old power agreement with the City expires in 1920. The new agreement is to provide for the continuation of a power supply through the Commission and to take care of the growth in power demand in Port Arthur and the vicinity.

Fort William also voted (700 for to 71 against) on this date and agreed that the Commission would provide power in excess of that required from Kaministiquia Power Company. Both agreements would become effective on December 1920.

Surveys of possible power developments on the Nipigon River for the supply of power to Port Arthur, Fort William and surrounding districts were carried on throughout December and the fall of 1917. These investigations showed that there was an available head of 115 ft. between Lake Jessie and Camp Alexander. This total development would provide a capacity of 100,000 horse-power, but this amount was considered to be too great for the immediate future requirements of the district. It was therefore decided in 1918, to proceed with a 58 ft. development at Camerons Pool. This initial development had an expected capacity of aprox. 50,000 horse-power.

In 1919 the power taken by the Municipality of Port Arthur from the Commission's transformer station had shown a decided increase over the previous year. During the year it was found necessary to increase the power held in reserve from the Kam Power Company from 5,000 to 6,000 horse-power. Also some restringing of the existing 22 KV power lines took place to keep pace with the increased load demand.

In early 1919 a temporary power plant was constructed at the Cameron Falls site in order to supply power and lighting for construction purposes. The plant utilized a 20 ft. head and generated about 1,400 hp. from two vertical turbines. Construction then continued on the two 12,500 horse-power generators that would be put in place. These two generators would be single-runner, vertical units, operating under 72 ft. head at 120 rpm. They were manufactured by the I.P.Morris Company of Philadelphia. The present installation would consist of two units but would eventually become six. Power would be transmitted on wood pole lines a distance of 60 miles to Port Arthur and Fort William.

During the year 1920, the demand for power in Port Arthur increased steadily, necessitating the ordering of additional amounts of power from time to time from the Kam Power Company. Also indications at the time were that a number of new pulp and paper mill industries would be establishing in the city during the coming year, which, together with the extensions being constructed to existing industries would require additional amounts of power from the new development at Cameron Falls.

On December 21st, 1920, the first unit at Cameron Falls was placed in service, as well as the new transmission line to Port Arthur and the transformer station at Bare Point. The plant and lines were turned over to the Operating department on the above date, power being transmitted temporarily at 60 kv. The second unit was placed in service on March 15th, 1921, the original unit having been run continuously from Dec. 21st, until that date. On August 7th, 1921, permanent switching equipment was placed in service and the transmission voltage was raised to 110 kv.

By 1922 the Cameron Falls plant had completed its second year of operation. The district load had now attained a value where both generators were necessary to carry the load and there was every indication that additional capacity would be required at the Nipigon development in a short time. There were no radical changes on the Thunder Bay system during this year.

By 1923 the regular increase in the load on the system had continued until the load on the plant required practically full output capacity of both generating units. It had also been found difficult to obtain a shutdown on a machine for even a few hours on a Sunday for cleaning purposes or minor repairs. Therefore the decision was made to construct an extension (aprox. 90 ft.) to the development at Cameron Falls. The construction work necessary for the installation of two more units of the same capacity began in September 1923. Also arrangements were made for supplying power to a large pulp and paper mill located in Fort William.

The load in the city of Port Arthur increased from 7,000 hp. to 21,000 hp. over the previous four years and is estimated that during the next fiscal year it would reach 40,000 hp. During the year 1924, service was given for the first time to the Great Lakes Paper Company in Fort William. This company was taking 12,000 hp. Also service was resumed to the Nipigon Pulp Mill which was now taking 3,000 hp.

The two additional generating units were placed in service in this year. G3 went into operation on June 24 and G4 on September 27, 1924, each having a capacity of 12,500 hp.(Plant capacity was now 50,000 hp.) The original transmission line was paralleled by a new circuit supported on steel towers, and an extension of fifteen miles of single circuit transmission line supported on steel towers from Port Arthur to Fort William was also placed in operation.

It was now found that while one machine at a time may be removed from service for short periods at certain hours of the night for cleaning, or for minor repairs, the normal day load, on account of heavy momentary fluctuations required the use of all four machines. The necessity of additional generating units at this station was already apparent, since any major repair operation on any machine could not be attempted.

The installation of the fifth and sixth units required the flow of the river to be regulated to ensure an adequate supply of water at all times. Lake Nipigon, having an area of over 1,500 square miles, offers exceptional opportunities for storage, and investigations showed that a range of water levels on this lake of nine feet could be secured without undue expense for land damages or control works. This variation was sufficient for complete regulation of the run-off not only from the Nipigon drainage area, but also from other drainage areas. It was proposed to construct a regulating dam (Virgin Falls Dam) at the outlet of the lake to control the outflow and regulate the levels within the range above referred to. Also at this time preliminary reconnaissance and surveys were made during the year to determine the feasibility of utilizing some of the waters of the James Bay watershed. Information on this subject was gathered and studied.

The Thunder Bay system during 1925 established another remarkable increase in the demand for electrical energy. During the year units No. 5 and No. 6 were installed and placed in operation, thus with an installed capacity of 75,000 horsepower, completing this development as originally planned. The dam at Virgin Falls for conserving water by creating storage on lake Nipigon was also completed.

During the previous year the average load on the system increased by 10,357 horsepower, and reached a total of 37,612 horsepower. The 20 minute peak load in December, 1925, reached a total of 50,200 horsepower, exceeding that of 1924 by 12,400 horsepower.

The existing pulp and paper mills, as a result of the acquisition by the companies of new timber limits, were to be greatly enlarged, and to take care of additional power requirements the Commission had found it necessary to plan for an immediate additional development at Alexander Landing. The Commission was also making further studies of other sites on the Nipigon river, particularly one at a point above Cameron Falls.

Negotiations which had been carried on with existing companies, together with applications for power that had already been received, make it probable that the demand for power would, by 1932, be about 150,000 horsepower.

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Appendix 2B

Nipigon River Flows at Pine Portage Generating Station (1951 - 1990)
Lake Nipigon Levels at Macdiarmid (1951 - 1992)

Nipigon River Daily Flows at Pine Portage Generating Station (1951 - 1990)

- Flows statistics by decade
- Number of days when flow < 270.0 m^3/s
- Number of days when flow < 260.0 m^3/s
- Number of days when flow < 170.0 m^3/s
- Number of days when flow < 100.0 m^3/s

NIPIGON RIVER AT PINE PORTAGE WSC NO. 02AD008
DAILY FLOW

YEARS: 1951-1960	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
MEAN (M3/S)	391.	408.	406.	376.	333.	359.	385.	354.	332.	342.	349.	363.	366.
ST. DEV. (M3/S)	70.	71.	93.	98.	89.	99.	95.	69.	60.	50.	52.	69.	78.
MAXIMUM (M3/S)	538.	538.	547.	547.	564.	600.	592.	547.	464.	501.	459.	527.	600.
MINIMUM (M3/S)	169.	242.	206.	171.	140.	117.	81.	173.	109.	197.	134.	88.	81.

YEARS: 1961-1970	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
MEAN (M3/S)	356.	370.	378.	375.	359.	413.	417.	407.	385.	385.	393.	372.	384.
ST. DEV. (M3/S)	90.	92.	95.	83.	107.	120.	142.	115.	102.	96.	112.	121.	107.
MAXIMUM (M3/S)	575.	595.	583.	580.	609.	606.	629.	640.	597.	629.	631.	640.	640.
MINIMUM (M3/S)	96.	105.	128.	119.	102.	113.	87.	103.	86.	128.	127.	111.	86.

YEARS: 1971-1980	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
MEAN (M3/S)	370.	379.	374.	354.	322.	375.	347.	350.	325.	335.	328.	328.	349.
ST. DEV. (M3/S)	102.	103.	111.	123.	119.	114.	117.	93.	95.	80.	97.	91.	104.
MAXIMUM (M3/S)	561.	566.	569.	564.	578.	589.	583.	580.	473.	464.	493.	484.	589.
MINIMUM (M3/S)	1.	148.	119.	115.	60.	98.	33.	35.	44.	68.	106.	75.	1.

YEARS: 1981-1990	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
MEAN (M3/S)	332.	351.	333.	289.	248.	289.	299.	294.	300.	352.	324.	316.	310.
ST. DEV. (M3/S)	100.	106.	104.	109.	113.	126.	143.	107.	94.	126.	109.	109.	113.
MAXIMUM (M3/S)	553.	574.	553.	457.	562.	569.	569.	514.	589.	588.	571.	569.	589.
MINIMUM (M3/S)	101.	72.	104.	75.	83.	107.	48.	52.	113.	113.	104.	114.	48.

DAILY FLOW FROM PINE PORTAGE < 270.0 M3/S

YEARS: 1951-1960	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
NO. OF DAYS	15	36	17	45	58	58	21	27	47	24	31	25	404
(%)	4.8	12.7	5.5	15.0	18.7	19.3	6.8	8.7	15.7	7.7	10.3	8.1	11.1

YEARS: 1961-1970	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
NO. OF DAYS	57	68	36	40	52	48	57	37	54	35	46	57	587
(%)	18.4	24.1	11.6	13.3	16.8	16.0	18.4	11.9	18.0	11.3	15.3	18.4	16.1

YEARS: 1971-1980	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
NO. OF DAYS	59	72	67	103	114	63	64	56	84	66	95	88	931
(%)	19.0	25.4	21.6	34.3	36.8	21.0	20.6	18.1	28.0	21.3	31.7	28.4	25.5

YEARS: 1981-1990	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
NO. OF DAYS	56	57	67	113	162	136	146	137	122	76	81	76	1229
(%)	18.1	20.2	21.6	37.7	52.3	45.3	47.1	44.2	40.7	24.5	27.0	24.5	33.7

DAILY FLOW FROM PINE PORTAGE < 260.0 M3/S

YEARS: 1951-1960	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
NO. OF DAYS	11	31	13	37	44	51	17	21	39	19	25	23	331
(%)	3.5	11.0	4.2	12.3	14.2	17.0	5.5	6.8	13.0	6.1	8.3	7.4	9.1

YEARS: 1961-1970	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
NO. OF DAYS	54	62	33	38	48	47	48	31	45	29	43	54	532
(%)	17.4	22.0	10.6	12.7	15.5	15.7	15.5	10.0	15.0	9.4	14.3	17.4	14.6

YEARS: 1971-1980	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
NO. OF DAYS	51	68	63	89	111	54	56	51	73	58	88	76	838
(%)	16.5	24.0	20.3	29.7	35.8	18.0	18.1	16.5	24.3	18.7	29.3	24.5	22.9

YEARS: 1981-1990	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
NO. OF DAYS	51	57	66	109	151	130	142	137	114	71	80	67	1175
(%)	16.5	20.2	21.3	36.3	48.7	43.3	45.8	44.2	38.0	22.9	26.7	21.6	32.2

DAILY FLOW FROM PINE PORTAGE < 170.0 M3/S

YEARS: 1951-1960	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
NO. OF DAYS	1	27	0	10	5	14	3	0	15	0	11	5	91
(%)	0.3	9.5	0.0	3.3	1.6	4.7	1.0	0.0	5.0	0.0	3.7	1.6	2.5

YEARS: 1961-1970	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
NO. OF DAYS	12	36	9	16	17	21	14	5	17	6	14	17	184
(%)	3.9	12.8	2.9	5.3	5.5	7.0	4.5	1.6	5.7	1.9	4.7	5.5	5.0

YEARS: 1971-1980	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
NO. OF DAYS	6	32	6	26	27	16	27	9	35	12	39	16	251
(%)	1.9	11.3	1.9	8.7	8.7	5.3	8.7	2.9	11.7	3.9	13.0	5.2	6.9

YEARS: 1981-1990	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
NO. OF DAYS	34	56	35	80	96	82	65	36	33	22	56	54	649
(%)	11.0	19.9	11.3	26.7	31.0	27.3	21.0	11.6	11.0	7.1	18.7	17.4	17.8

DAILY FLOW FROM PINE PORTAGE < 100.0 M3/S

YEARS: 1951-1960	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
NO. OF DAYS	0	27	0	10	0	10	1	0	10	0	10	1	69
(%)	0.0	9.5	0.0	3.3	0.0	3.3	0.3	0.0	3.3	0.0	3.3	0.3	1.9

YEARS: 1961-1970	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
NO. OF DAYS	1	28	0	10	0	10	3	0	12	0	10	0	74
(%)	0.3	9.9	0.0	3.3	0.0	3.3	1.0	0.0	4.0	0.0	3.3	0.0	2.0

YEARS: 1971-1980	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
NO. OF DAYS	2	27	0	10	4	11	3	3	17	4	10	3	94
(%)	0.6	9.5	0.0	3.3	1.3	3.7	1.0	1.0	5.7	1.3	3.3	1.0	2.6

YEARS: 1981-1990	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
NO. OF DAYS	0	30	0	11	4	10	4	3	10	0	10	0	82
(%)	0.0	10.6	0.0	3.7	1.3	3.3	1.3	1.0	3.3	0.0	3.3	0.0	2.2

Lake Nipigon Daily Levels at Macdiarmid (1951 - 1992)

- Level statistics by decade
- Number of days when level < 259.30 m
- Number of days when level < 259.83 m
- Number of days when level > 260.00 m
- Number of days when level > 260.30 m
- Number of days when level > 260.60 m

DAILY WATER LEVEL AT LAKE NIPIGON (AT MACDIARMID)

YEARS: 1951-1960	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
MEAN (M)	259.91	259.80	259.68	259.58	259.76	260.06	260.21	260.19	260.13	260.07	260.01	259.92	259.94
ST. DEV. (M)	0.187	0.162	0.136	0.109	0.209	0.205	0.156	0.136	0.141	0.186	0.211	0.233	0.176
MAXIMUM (M)	260.20	260.09	259.98	259.83	260.37	260.56	260.56	260.44	260.31	260.30	260.32	260.26	260.56
MINIMUM (M)	259.51	259.46	259.38	259.35	259.37	259.64	259.85	259.80	259.73	259.55	259.53	259.44	259.35
MAX RANGE (M)	0.13	0.17	0.20	0.18	0.68	0.48	0.24	0.14	0.16	0.22	0.21	0.16	0.68

YEARS: 1961-1970	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	291	287	303	270	302	310	300	290	283	302	3530
MEAN (M)	259.77	259.68	259.56	259.46	259.63	260.00	260.18	260.18	260.15	260.11	260.05	259.94	259.89
ST. DEV. (M)	0.208	0.206	0.184	0.136	0.167	0.190	0.204	0.193	0.201	0.227	0.254	0.226	0.201
MAXIMUM (M)	260.18	260.14	259.97	259.73	259.97	260.39	260.48	260.45	260.41	260.51	260.54	260.43	260.54
MINIMUM (M)	259.36	259.29	259.23	259.21	259.34	259.58	259.85	259.78	259.70	259.68	259.68	259.60	259.21
MAX RANGE (M)	0.17	0.23	0.23	0.16	0.45	0.44	0.18	0.13	0.15	0.24	0.17	0.20	0.45

YEARS: 1971-1980	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	243	289	300	310	300	310	310	300	310	300	310	3592
MEAN (M)	259.72	259.57	259.50	259.42	259.58	259.82	259.93	259.92	259.88	259.83	259.80	259.72	259.73
ST. DEV. (M)	0.449	0.444	0.403	0.339	0.305	0.358	0.308	0.287	0.291	0.327	0.388	0.426	0.363
MAXIMUM (M)	260.30	260.17	260.04	259.83	260.35	260.52	260.53	260.44	260.34	260.34	260.37	260.33	260.53
MINIMUM (M)	258.70	258.64	258.61	258.61	258.84	259.09	259.38	259.54	259.42	259.21	258.94	258.79	258.61
MAX RANGE (M)	0.13	0.15	0.20	0.22	0.56	0.34	0.19	0.17	0.27	0.21	0.26	0.18	0.56

YEARS: 1981-1990	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
MEAN (M)	259.63	259.55	259.45	259.38	259.55	259.78	259.94	259.98	259.94	259.89	259.82	259.73	259.72
ST. DEV. (M)	0.323	0.296	0.252	0.214	0.258	0.288	0.279	0.251	0.263	0.300	0.312	0.321	0.281
MAXIMUM (M)	260.33	260.22	260.05	259.90	260.21	260.31	260.33	260.30	260.32	260.36	260.36	260.35	260.36
MINIMUM (M)	259.02	259.01	259.00	259.01	259.04	259.37	259.52	259.47	259.29	259.17	259.10	259.03	259.00
MAX RANGE (M)	0.15	0.16	0.18	0.18	0.43	0.33	0.23	0.28	0.21	0.21	0.23	0.17	0.43

YEARS: 1991-1992	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	39	50	62	51	62	57	60	40	46	62	49	14	592
MEAN (M)	259.65	259.58	259.48	259.41	259.66	259.97	260.09	260.03	260.05	260.06	259.89	259.67	259.80
ST. DEV. (M)	0.028	0.026	0.033	0.019	0.157	0.102	0.113	0.143	0.291	0.312	0.223	0.016	0.164
MAXIMUM (M)	259.69	259.63	259.55	259.48	259.99	260.12	260.26	260.31	260.51	260.46	260.23	259.70	260.51
MINIMUM (M)	259.58	259.52	259.42	259.37	259.44	259.82	259.92	259.89	259.76	259.62	259.67	259.64	259.37
MAX RANGE (M)	0.11	0.11	0.11	0.11	0.55	0.14	0.15	0.13	0.16	0.21	0.15	0.06	0.55

MAX RANGE = MAXIMUM RANGE OF WATER LEVEL OCCURRING AT THAT MONTH

LAKE NIPIGON DAILY WATER LEVEL (AT MACDIARMID) < 259.30 M

YEARS: 1951-1960	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
NO. OF DAYS	0	0	0	0	0	0	0	0	0	0	0	0	0
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

YEARS: 1961-1970	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	291	287	303	270	302	310	300	290	283	302	3530
NO. OF DAYS	0	2	44	66	0	0	0	0	0	0	0	0	112
(%)	0.0	0.7	15.1	23.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2

YEARS: 1971-1980	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	243	289	300	310	300	310	310	300	310	300	310	3592
NO. OF DAYS	62	56	62	79	57	28	0	0	0	13	56	62	475
(%)	20.0	23.0	21.5	26.3	18.4	9.3	0.0	0.0	0.0	4.2	18.7	20.0	13.2

YEARS: 1981-1990	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
NO. OF DAYS	31	53	74	90	53	0	0	0	1	29	30	31	392
(%)	10.0	18.8	23.9	30.0	17.1	0.0	0.0	0.0	0.3	9.4	10.0	10.0	10.7

YEARS: 1991-1992	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	39	50	62	51	62	57	60	40	46	62	49	14	592
NO. OF DAYS	0	0	0	0	0	0	0	0	0	0	0	0	0
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

LAKE NIPIGON DAILY WATER LEVEL (AT MACDIARMID) < 259.83 M

YEARS: 1951-1960	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
NO. OF DAYS	97	150	270	299	202	30	0	6	25	31	58	100	1268
(%)	31.3	53.0	87.1	99.7	65.2	10.0	0.0	1.9	8.3	10.0	19.3	32.3	34.7

YEARS: 1961-1970	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
TOTAL (DAYS)	310	282	291	287	303	270	302	310	300	290	283	302	3530
NO. OF DAYS	194	228	272	287	255	57	0	19	30	58	74	124	1598
(%)	62.6	80.9	93.5	100.0	84.2	21.1	0.0	6.1	10.0	20.0	26.1	41.1	45.3

YEARS: 1971-1980	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
TOTAL (DAYS)	310	243	289	300	310	300	310	310	300	310	300	310	3592
NO. OF DAYS	146	170	222	299	268	153	155	154	123	122	130	129	2071
(%)	47.1	70.0	76.8	99.7	86.5	51.0	50.0	49.7	41.0	39.4	43.3	41.6	57.7

YEARS: 1981-1990	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
NO. OF DAYS	248	238	279	285	258	156	140	93	90	88	154	243	2272
(%)	80.0	84.4	90.0	95.0	83.2	52.0	45.2	30.0	30.0	28.4	51.3	78.4	62.2

YEARS: 1991-1992	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
TOTAL (DAYS)	39	50	62	51	62	57	60	40	46	62	49	14	592
NO. OF DAYS	39	50	62	51	52	1	0	0	8	31	30	14	338
(%)	100.0	100.0	100.0	100.0	83.9	1.8	0.0	0.0	17.4	50.0	61.2	100.0	57.1

LAKE NIPIGON DAILY WATER LEVEL (AT MACDIARMID) > 260.00 M

YEARS: 1951-1960	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
NO. OF DAYS	115	33	0	0	31	169	273	278	250	206	180	125	1660
(%)	37.1	11.7	0.0	0.0	10.0	56.3	88.1	89.7	83.3	66.5	60.0	40.3	45.4

YEARS: 1961-1970	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	291	287	303	270	302	310	300	290	283	302	3530
NO. OF DAYS	44	25	0	0	0	133	213	234	227	189	146	126	1337
(%)	14.2	8.9	0.0	0.0	0.0	49.3	70.5	75.5	75.7	65.2	51.6	41.7	37.9

YEARS: 1971-1980	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	243	289	300	310	300	310	310	300	310	300	310	3592
NO. OF DAYS	93	41	7	0	22	97	147	131	99	74	94	92	897
(%)	30.0	16.9	2.4	0.0	7.1	32.3	47.4	42.3	33.0	23.9	31.3	29.7	25.0

YEARS: 1981-1990	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
NO. OF DAYS	38	28	6	0	15	91	155	173	156	82	60	62	866
(%)	12.3	9.9	1.9	0.0	4.8	30.3	50.0	55.8	52.0	26.5	20.0	20.0	23.7

YEARS: 1991-1992	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	39	50	62	51	62	57	60	40	46	62	49	14	592
NO. OF DAYS	0	0	0	0	0	24	35	13	16	31	19	0	138
(%)	0.0	0.0	0.0	0.0	0.0	42.1	58.3	32.5	34.8	50.0	38.8	0.0	23.3

LAKE NIPIGON DAILY WATER LEVEL (AT MACDIARMID) > 260.30 M

YEARS: 1951-1960	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
NO. OF DAYS	0	0	0	0	4	35	66	36	1	1	2	0	145
(%)	0.0	0.0	0.0	0.0	1.3	11.7	21.3	11.6	0.3	0.3	0.7	0.0	4.0

YEARS: 1961-1970	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	291	287	303	270	302	310	300	290	283	302	3530
NO. OF DAYS	0	0	0	0	0	16	114	103	86	63	50	27	459
(%)	0.0	0.0	0.0	0.0	0.0	5.9	37.7	33.2	28.7	21.7	17.7	8.9	13.0

YEARS: 1971-1980	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	243	289	300	310	300	310	310	300	310	300	310	3592
NO. OF DAYS	0	0	0	0	5	30	31	45	48	20	29	8	216
(%)	0.0	0.0	0.0	0.0	1.6	10.0	10.0	14.5	16.0	6.5	9.7	2.6	6.0

YEARS: 1981-1990	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
NO. OF DAYS	10	0	0	0	0	1	9	0	5	33	17	27	102
(%)	3.2	0.0	0.0	0.0	0.0	0.3	2.9	0.0	1.7	10.6	5.7	8.7	2.8

YEARS: 1991-1992	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	39	50	62	51	62	57	60	40	46	62	49	14	592
NO. OF DAYS	0	0	0	0	0	0	0	2	16	22	0	0	40
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	34.8	35.5	0.0	0.0	6.8

LAKE NIPIGON DAILY WATER LEVEL (AT MACDIARMID) > 260.60 M

YEARS: 1951-1960	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	283	310	300	310	300	310	310	300	310	300	310	3653
NO. OF DAYS	0	0	0	0	0	0	0	0	0	0	0	0	0
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

YEARS: 1961-1970	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	291	287	303	270	302	310	300	290	283	302	3530
NO. OF DAYS	0	0	0	0	0	0	0	0	0	0	0	0	0
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

YEARS: 1971-1980	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	243	289	300	310	300	310	310	300	310	300	310	3592
NO. OF DAYS	0	0	0	0	0	0	0	0	0	0	0	0	0
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

YEARS: 1981-1990	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	310	282	310	300	310	300	310	310	300	310	300	310	3652
NO. OF DAYS	0	0	0	0	0	0	0	0	0	0	0	0	0
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

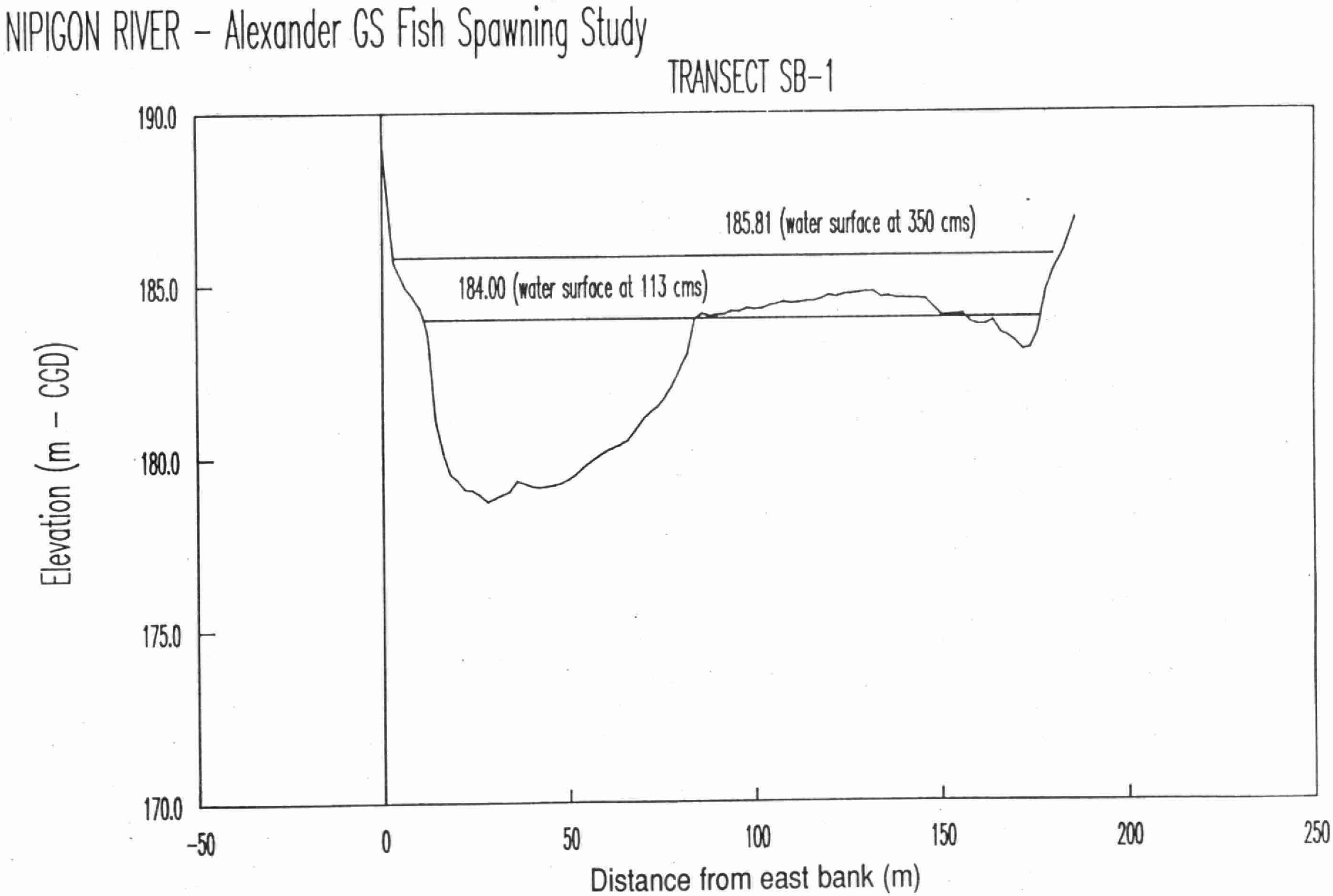
YEARS: 1991-1992	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOTAL (DAYS)	39	50	62	51	62	57	60	40	46	62	49	14	592
NO. OF DAYS	0	0	0	0	0	0	0	0	0	0	0	0	0
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 2B.1

Nipigon River cross-sections

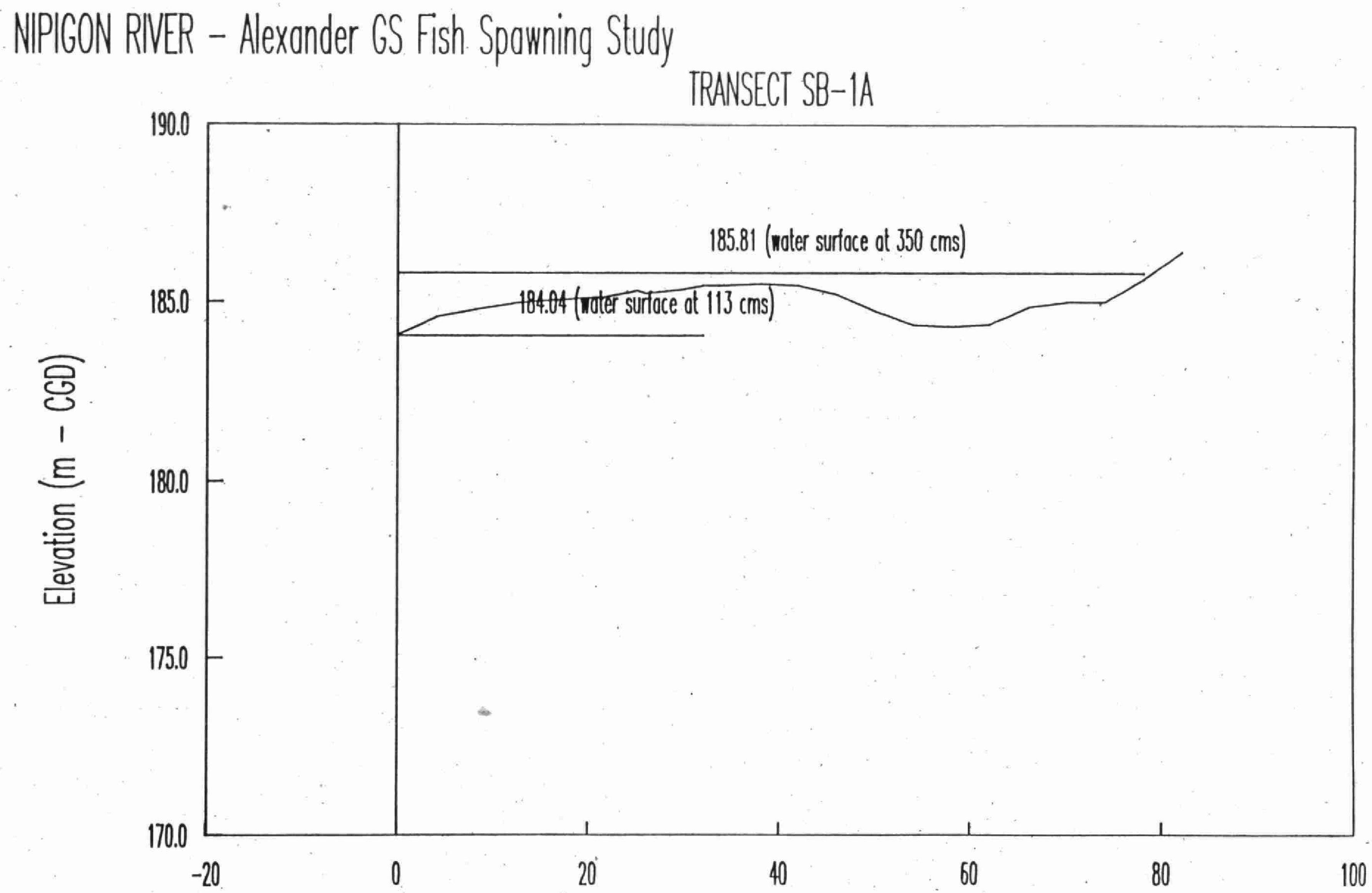
- Transects SB1
- Transects SB1a
- Transects SB2
- Transects SB3
- Transects SB4
- Transects SB5
- Transects SB6
- Transects SB7
- Transects SB8

(from Pope & Metcalfe, 1991, draft)



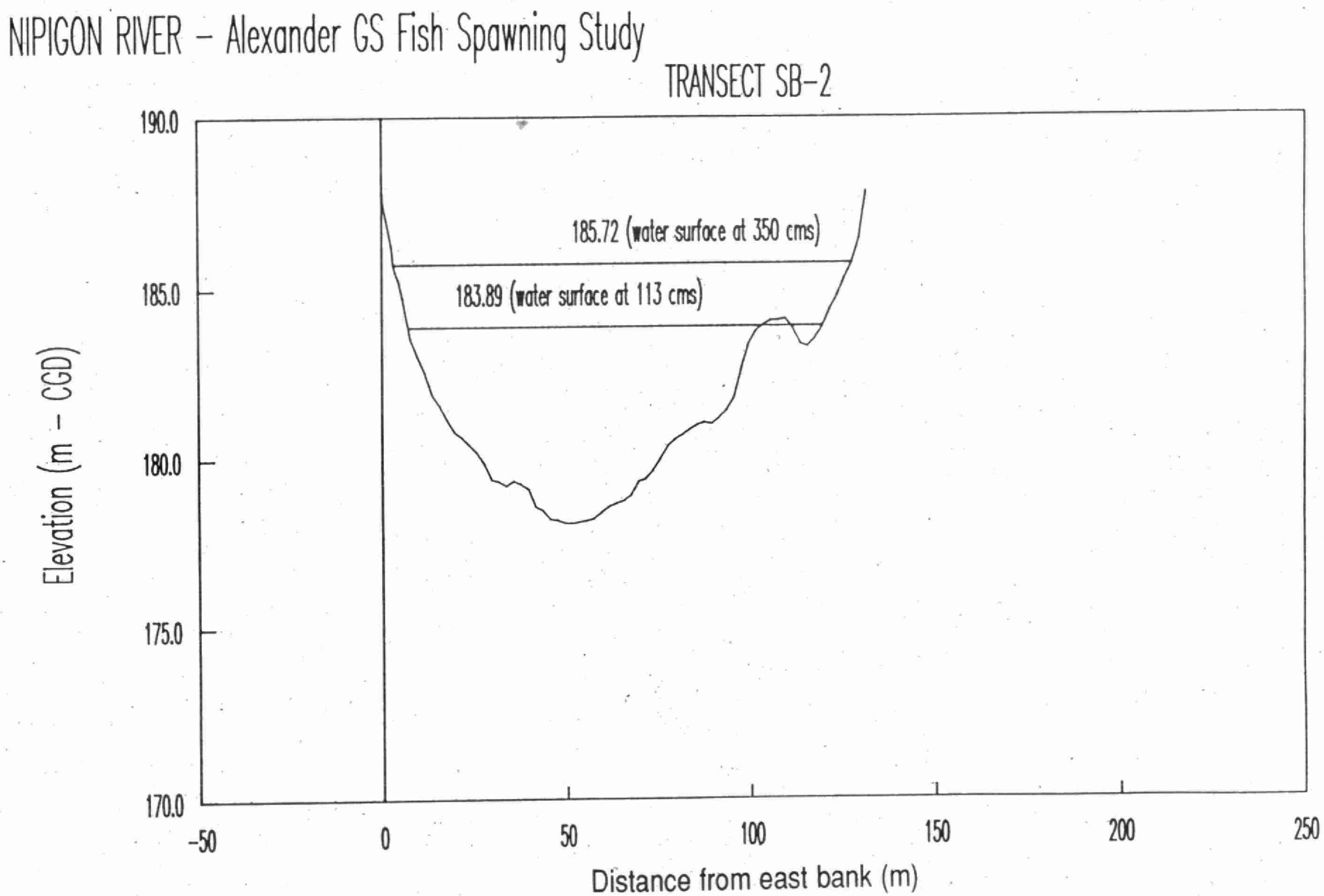
TRANSECT SB-1

(from Pope and Metcalfe, 1991, draft)



TRANSECT SB-1A

(from Pope and Metcalfe, 1991, draft)

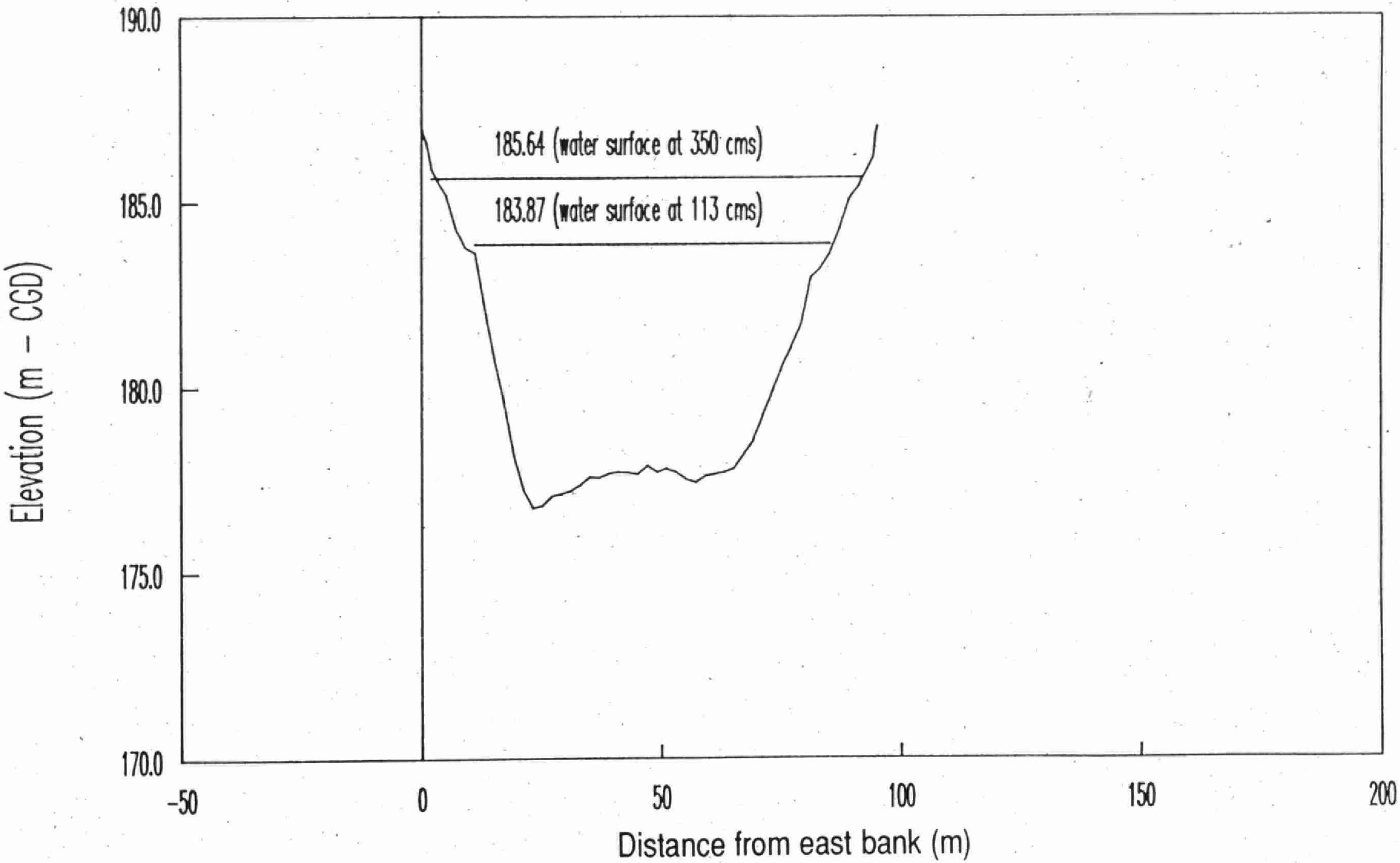


TRANSECT SB-2

(from Pope and Metcalfe, 1991, draft)

NIPIGON RIVER – Alexander GS Fish Spawning Study

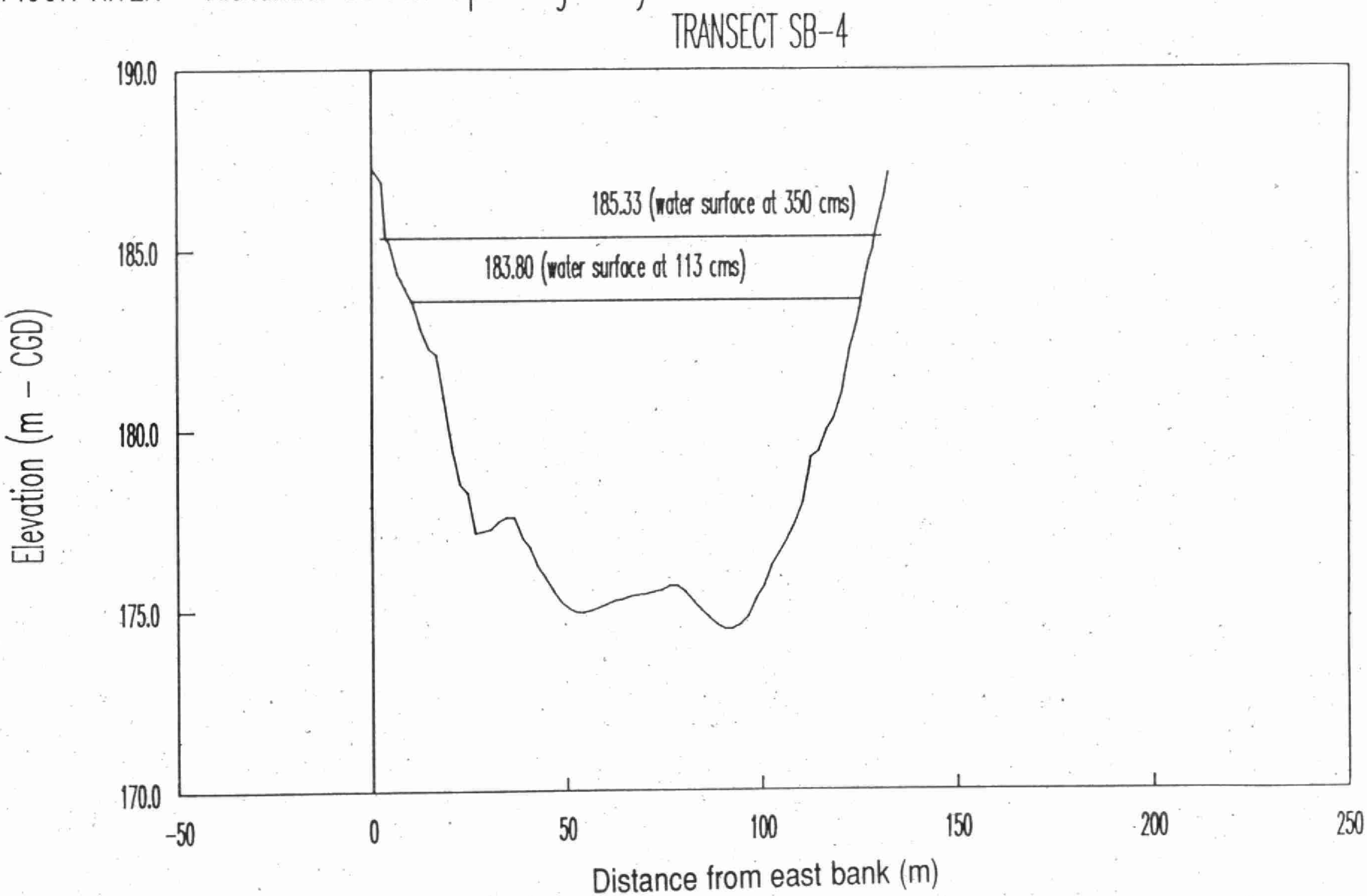
TRANSECT SB-3



TRANSECT SB-3

(from Pope and Metcalfe, 1991, draft)

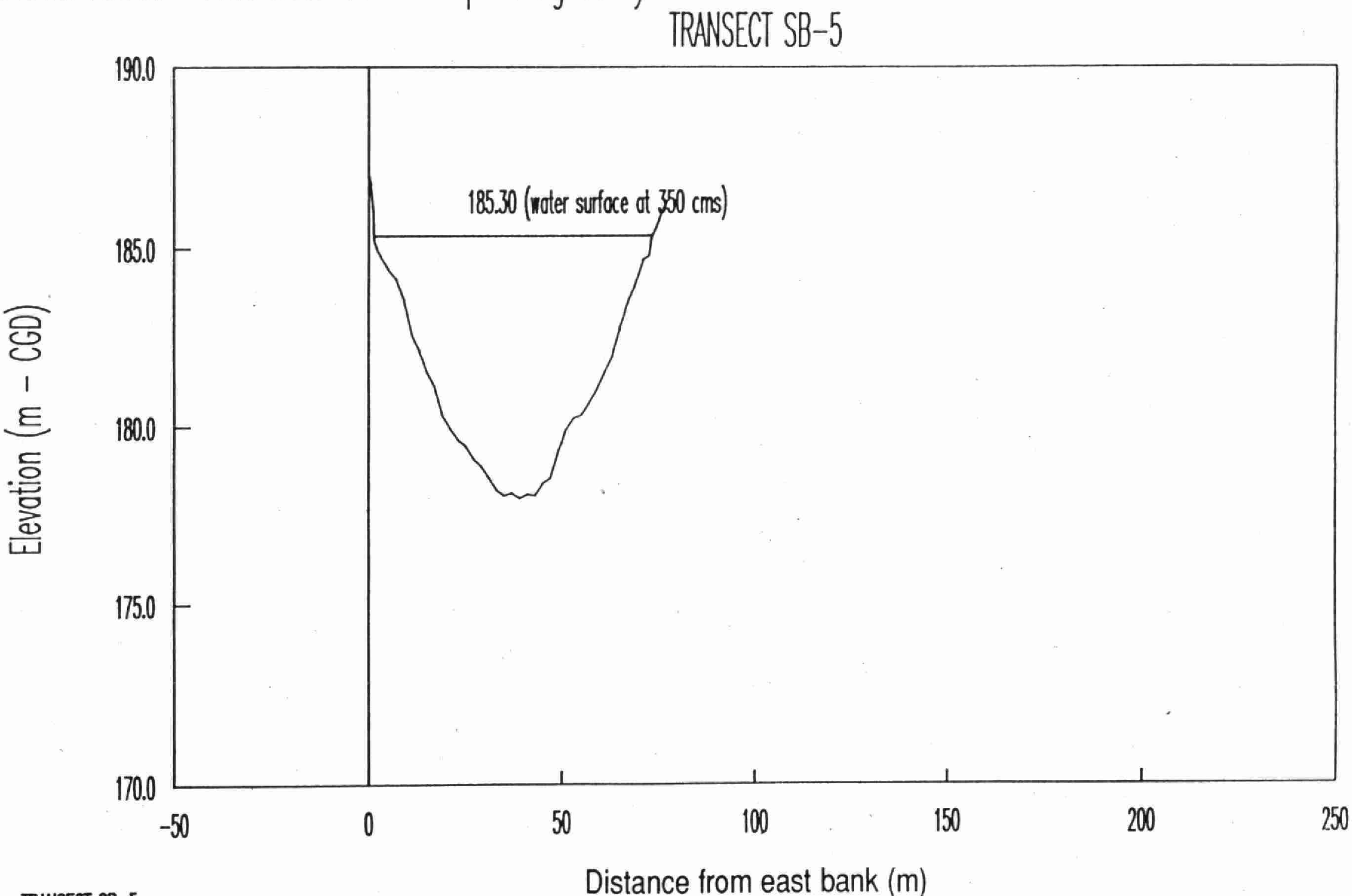
NIPIGON RIVER – Alexander GS Fish Spawning Study



TRANSECT SB-4

(from Pope and Metcalfe, 1991, draft)

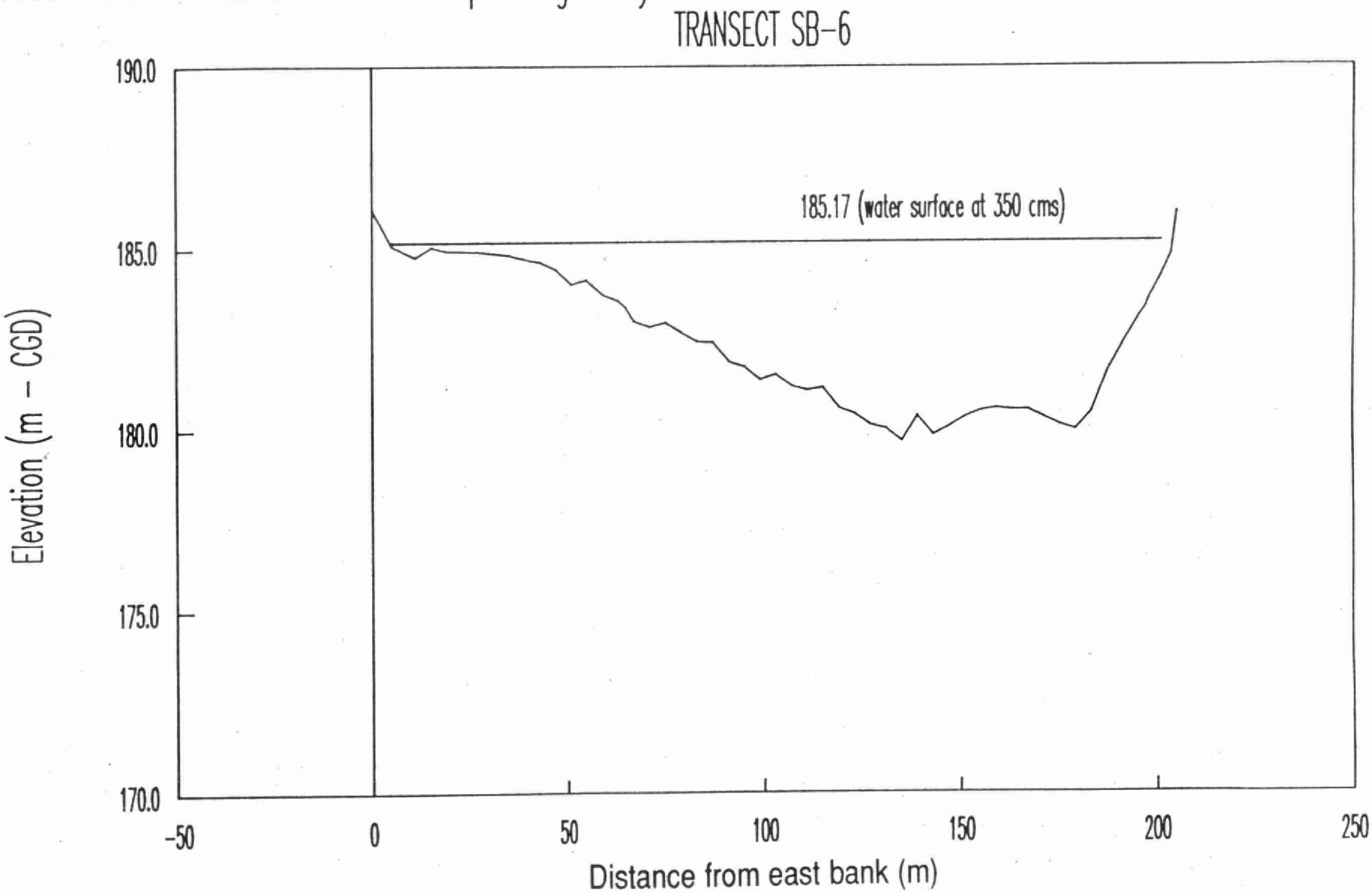
NIPIGON RIVER – Alexander GS Fish Spawning Study



TRANSECT SB-5

(from Pope and Metcalfe, 1991, draft)

NIPIGON RIVER – Alexander GS Fish Spawning Study

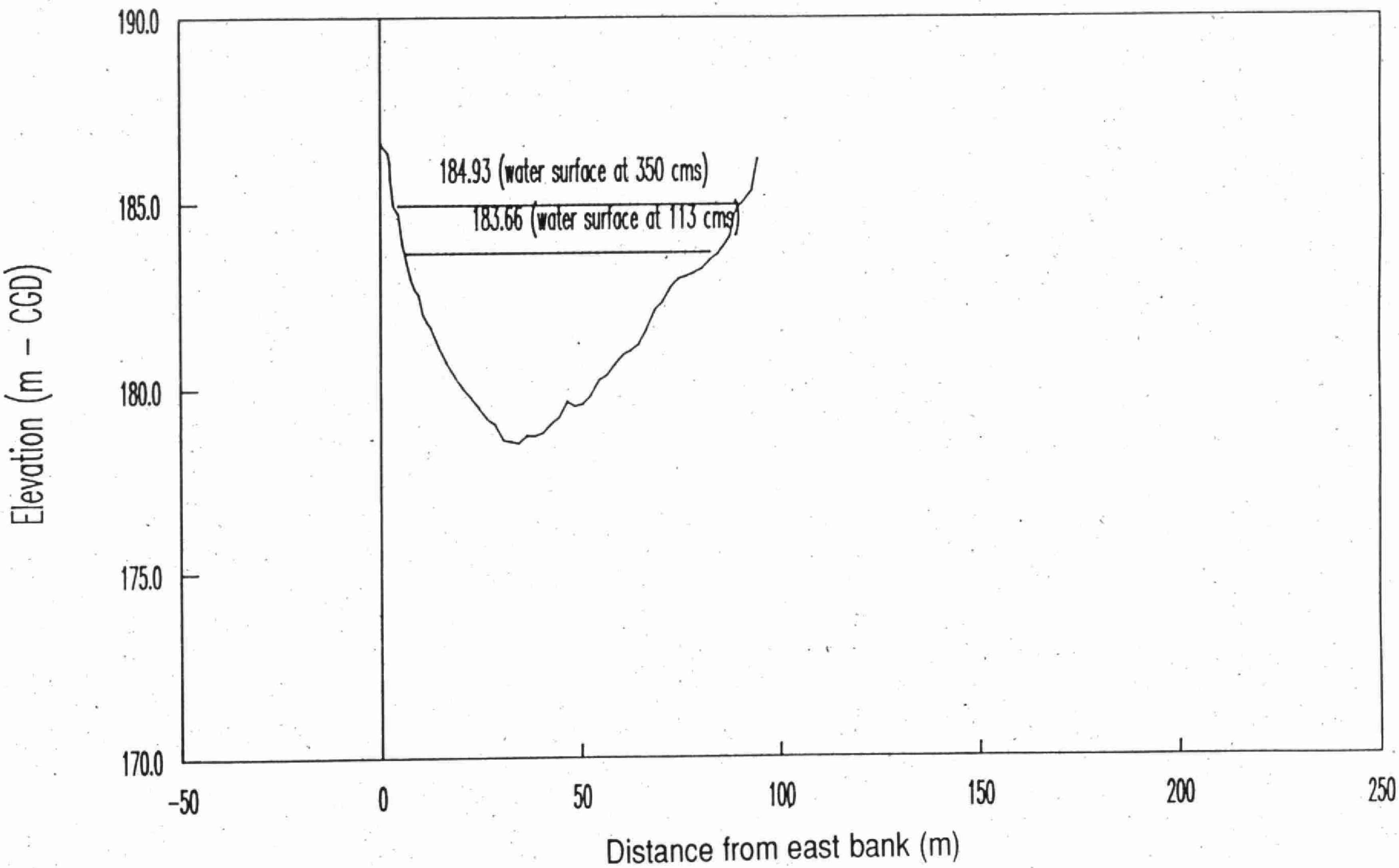


TRANSECT SB-6

(from Pope and Metcalfe, 1991, draft)

NIPIGON RIVER – Alexander GS Fish Spawning Study

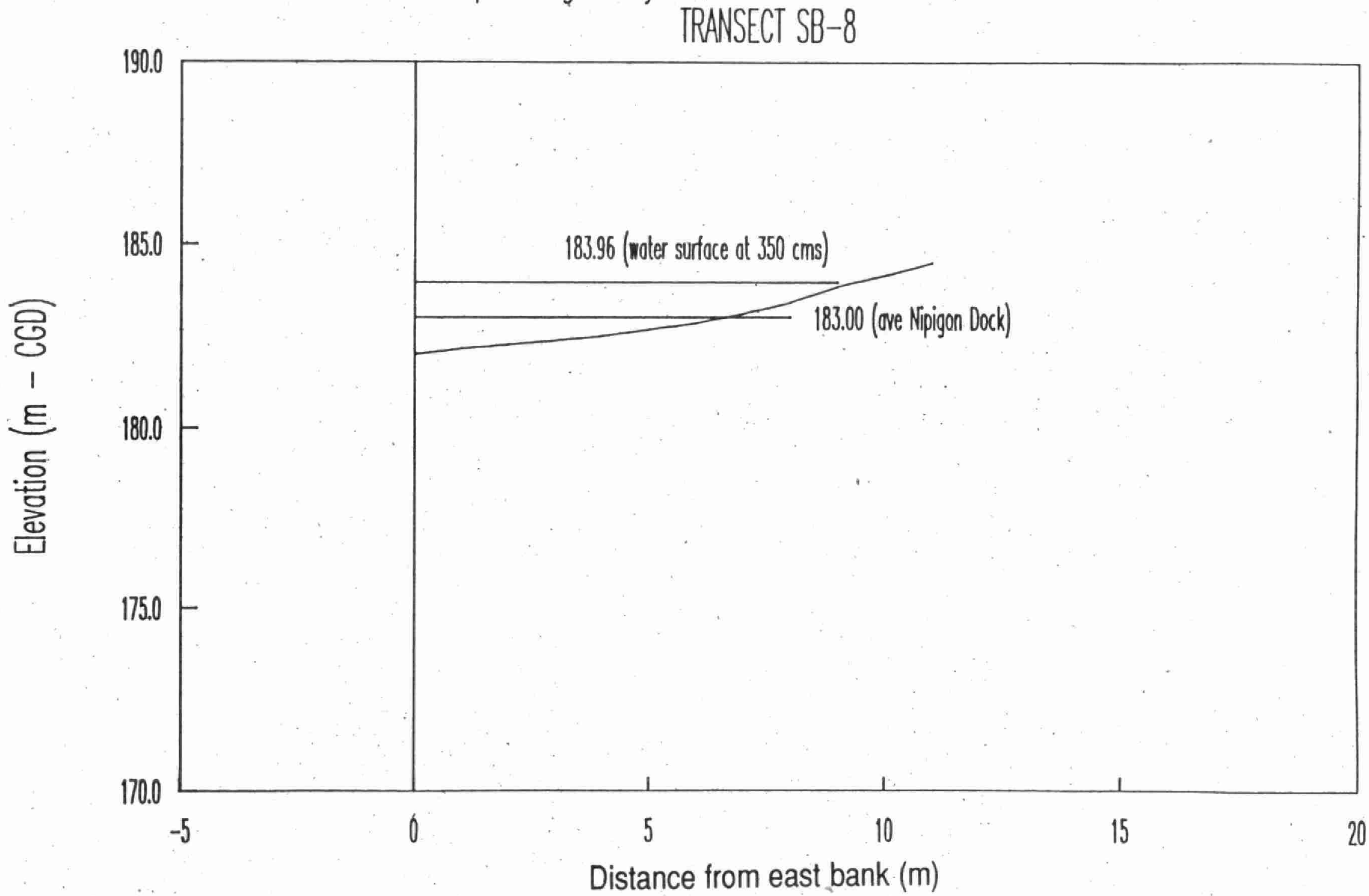
TRANSECT SB-7



TRANSECT SB-7

(from Pope and Metcalfe, 1991, draft)

NIPIGON RIVER – Alexander GS Fish Spawning Study

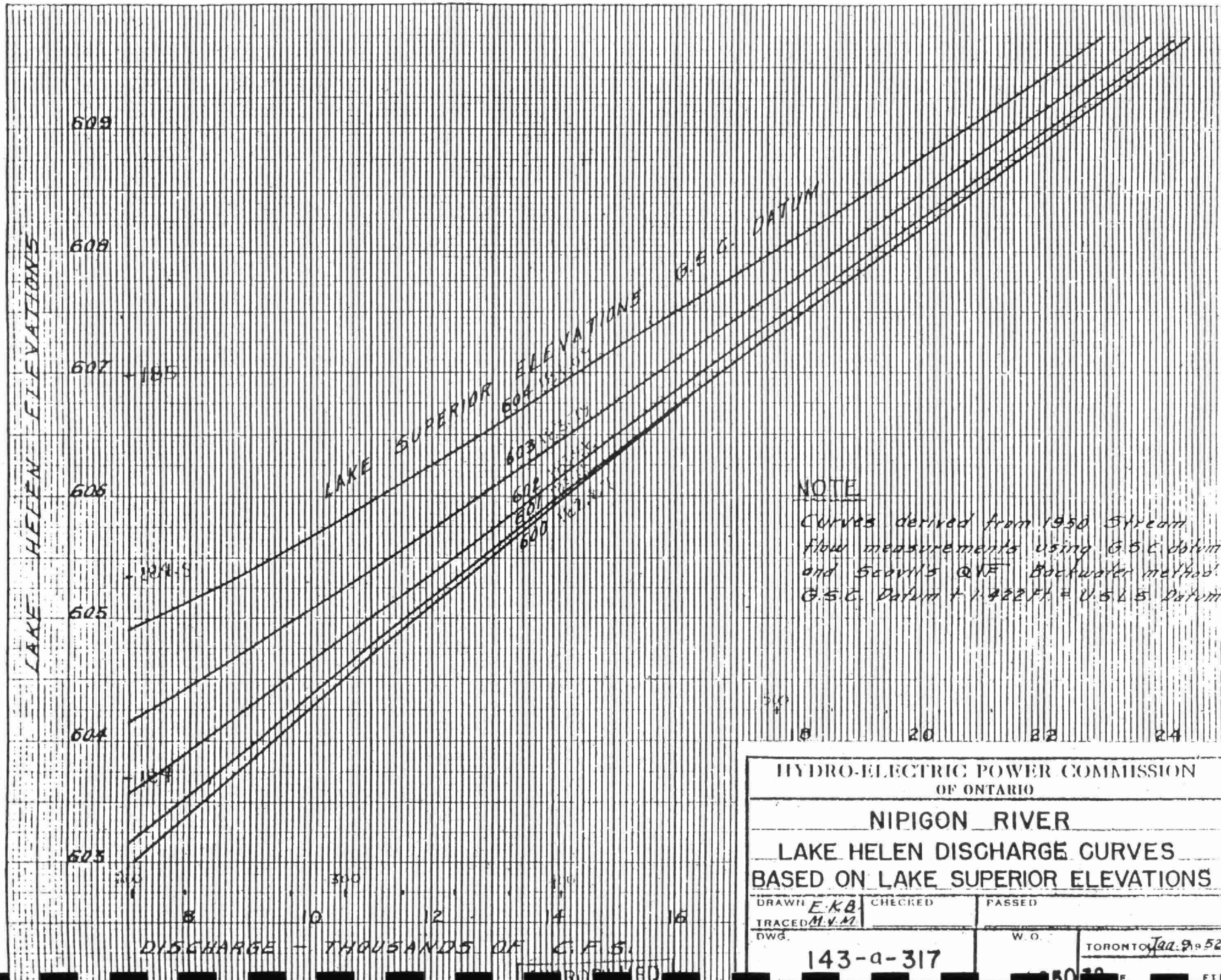


TRANSECT SB-8

(from Pope and Metcalfe, 1991, draft)

Appendix 2B.2

Ontario Hydro rating curves - Lake Helen



NOTE

Curves derived from 1950 Stream flow measurements using G.S.C. datum and Scovil's Q√F Backwater method. G.S.C. Datum + 1.422 Ft. = U.S.L.S. Datum

HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO

NIPIGON RIVER

LAKE HELEN DISCHARGE CURVES BASED ON LAKE SUPERIOR ELEVATIONS

DRAWN E.K.B. TRACED M.V.M.	CHECKED	PASSED
DWG. 143-a-317	W.O.	TORONTO Jan. 9 1952

Appendix 2B.3

Water level records - Lake Helen
(at Steamboat Bay)

- 1977 - 79 (partial)
- 1980 - 87

24065
rev. 11.69

1977-1978

hydraulic studies depart
generation projects divis

annual daily mean elevation or discharge sheet - wate

day	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sept
1									603.19	601.73	602.09	603.35
2									602.80	.61	N.R.	602.31
3									.76	.77	"	601.79
4									.65	.70	"	602.31
5									.57	.72	"	601.65
6									.66	602.07	"	.2[illegible]
7									.91	.06	"	.5[illegible]
8	N E W G A U G E								603.13	601.94	"	602.02
9									602.84	.56	"	.7[illegible]
10									603.33	.43	"	.29
11	I N S T A L L E D B Y								.33	.36	602.53	601.9[illegible]
12									.22	602.16	.70	.8[illegible]
13									.34	.39	.78	.95
14	B I L L H E N R Y								.72	.74	.42	.9[illegible]
15									.62	.65	.46	.75
16									.46	.32	.75	.7[illegible]
17	A N D								.57	.56	.71	602.0[illegible]
18									.78	.18	.93	.03
19									.51	.15	.83	601.9[illegible]
20	R O G E R W I L L I A M S							603.74	.63	.45	.84	.82
21								.36	604.12	.29	.60	602.1[illegible]
22								602.91	.08	601.88	603.04	603.2[illegible]
23	M A Y 20, 1977.							.45	603.87	.52	602.32	.70
24								.25	.92	.80	.64	.[illegible]
25								.73	.86	602.14	603.07	604.09
26								.85	.16	603.37	.16	.[illegible]
27								603.15	.30	602.65	.61	603.[illegible]
28								.06	.63	.56	.44	604.02
29								602.64	.42	.60	602.56	.[illegible]
30								.75	602.63	.73	.61	604.17
31								603.55		603.20	.62	
mean								602.95	603.33	602.17	602.76	602.[illegible]
max								603.74	604.12	603.37	603.61	604.22
min								602.25	602.57	601.36	602.09	601.[illegible]

water year maximum

water year minimum

remarks:

C.G.DATUM

[X] daily mean elevation in feet
[ ] daily mean discharge in cfs
[ ] daily mean outflow in cfs

[X] of
[ ] from
LAKE HELEN

[X] lake
[ ] river
[ ] creek

year ending september 30, 19[illegible]7

at ~~[illegible]~~ STEAMBOAT BAY

Nipigon River

24066
rev. 11-69

hydraulic studies departr
generation projects divi

annual daily mean elevation or discharge sheet - water

day	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sept
1	604.09											
2	.06											
3	.10											
4	.10											
5	.12											
6	.13											
7	.43											
8	602.85											
9	601.65											
10	602.29											
11	603.27											
12												
13			Gauge Removed									
14												
15			From									
16												
17			Service									
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												
31												
mean												
max												
min												

water year maximum

water year minimum

remarks: C.G. DATUM

RECORDING "F" GAUGE.

[X] daily mean elevation in feet
[ ] daily mean discharge in cfs

[X] of
[ ] from

LAKE HELEN

[X] lake
[ ] river
[ ] creek

year ending september 30, 197

at ~~XXXXXX~~ Steamboat Bay

NIPIGON RIVER

Ontario Hydro
Hydraulic Studies Department

new 78 12

annual daily mean elevation(metres) or discharge(m³/s)

day	jan.	feb.	mar.	apr.	may	jun.	jul.	aug.	sep.	oct.	nov.	dec.
1						3.86	4.32	4.26	4.16	4.17	4.33	3.90
2						.72	3.91	.28	.13	.18	.35	.66
3						.66	.83	.27	3.92	.13	3.98	.64
4						.67	4.03	.19	.72	.16	.71	.93
5						.68	.13	.00	.93	.18	.84	4.15
6						.69	.24	3.07	4.07	.13	4.17	.06
7						.76	.25	.99	.16	.16	.18	.07
8						.81	.24	4.23	.22	.15	.28	3.86
9						.99	.24	.30	.22	.17	.32	.69
10						4.19	.21	.24	.25	4.22	.03	.78
11						.26	.11	.21	.25	.23	3.82	4.15
12						.22	.12	.22	.26	.26	.88	.24
13						.14	.14	.24	.22	.33	4.18	.31
14						.05	.19	.26	.21	.34	.24	.31
15						.10	.21	.20	4.27	.30	.19	.23
16						.21	.29	.19	.19	.33	.28	.26
17						.25	.33	.30	.17	.34	3.99	.24
18						.23	.31	.33	.11	.35	.71	.26
19						.16	.34	.33	.13	.29	.74	.32
20						4.13	.25	4.29	.15	4.05	4.00	4.29
21						.08	3.88	.32	.12	3.94	.09	.23
22						.11	.72	.32	.08	.97	.11	.18
23						.15	.80	.25	.04	.97	.09	.15
24						.18	.85	.34	.02	4.05	3.80	.08
25						.19	.87	.39	4.03	.05	.59	3.82
26						.21	.98	.28	.04	.16	.67	.68
27						.24	4.03	.19	3.98	.26	.97	.96
28						.25	.19	.27	4.06	.18	.99	4.08
29						.33	.26	.31	.19	.02	4.09	.19
30						4.37	.22	.27	4.23	.18	.17	.22
31					4.00		4.24	4.27		4.26		4.19
mean						4.06	4.12	4.24	4.12	4.18	4.03	4.07
max.						4.37	4.34	4.39	4.27	4.35	4.35	4.32
min.						3.66	3.72	3.87	3.72	3.94	3.59	3.64

yearly maximum

yearly minimum

remarks: Bristol Recording Gauge
Add 180.00 m to obtain elevation referred to C.G.D.

[/] daily mean elevation in metres
[ ] daily mean discharge in m³/s
[ ] daily mean outflow in m³

[/] lake / from

LAKE HELEN

lake / river

year 1979

Steamboat Bay

NIPIGON RIVER

Rev. 78 12

Ontario Hydro
Hydraulic Studies Department

annual daily mean elevation(metres) or discharge(m³/s)

day	jan.	feb.	mar.	apr.	may	jun.	jul.	aug.	sep.	oct.	nov.	dec.	day
1	3.97	4.46	4.75e	4.52	3.57	3.73	3.75	3.93	3.61	3.88	3.65	3.38	1
2	4.06	.45	.72	.51	.48	.74	.53	4.05	.46	.83	.55	.58	2
3	.20	.45	.67	.51	.54	.86	.75	.12	.63	.83	.48	.73	3
4	.28	.48	.64	.52	.56	.98	.77	.21	.81	.81	.44	.57	4
5	.24	.46	.63	.52	.58	4.26	.92	.24	.78	.74	.42	.48	5
6	.22	.44	.63	.52	.61	.32	.76	.26	.74	.69	.43	.42	6
7	.23	.44	.63	.51	.63	.18	.74	.26	.62	.85	.39	.33	7
8	.27	.43	.62	.50*	.83	3.97	.88	.29	.64	.79	.71	.32	8
9	.33	.41	.61	.47*	.88	.86	.97	.27	.78	.77	.82	.36	9
10	4.35	4.43	4.61	4.22	3.97*	4.06	4.04	4.25	3.93	.80	3.82	3.48	10
11	.33	.40	.64	.15	N.R.	3.94	.00	.28	4.02	4.02	.67	.60	11
12	.36	.41	.66	.05	N.R.	.95	.01	.21	3.95	3.96	.51	.74	12
13	.36	.38	.64	3.84	N.R.	4.14	3.97	.23	4.03	4.02	.48	.98	13
14	.34	.37	.62	.67	N.R.	3.96	4.01	.28	3.86	.06	.55	.91	14
15	.32	.36	.60	4.05	4.11	.88	.18	.27	.93	.19	.49	.85	15
16	.30	.36	.60	.19	.05	.83	.22	.36	4.15	.18	.40	.68	16
17	.25	.37	.59	.24	3.87	.84	.15	.37	.23	.15	.40	.59	17
18	.26	.37	.57	.29	.54	.84	.06	.41	.13	.24	.49	.53	18
19	.26	.40	.56	.05	.42	.93	.11	.37	.09	.20	.47	.68	19
20	4.26	4.49	4.56	3.68	.49	.89	4.09	4.35	.00	4.14	3.49	3.57	20
21	.27	.42	.55	.75	.87	.73	.11	.35	3.84	.17	.49	.61	21
22	.27	.35	.55	.85	4.03	.67	.11	.33	.88	.16	.46	.72	22
23	.37	.33	.55	.77	.10	.98	.02	.31	.96	.22	.37	.80	23
24	.42	.32	.55	.54	3.92	4.09	.02	.31	.94	.31	.41	.78	24
25	.45	.37	.55	.43	.65	.17	.00	.31	.99	.35	.51	.44	25
26	.51	.55e	.55	.41	.58	.24	.03	.31	4.11	.31	.49	.33	26
27	.47	.62e	.55	.45	.72	.22	3.99	.29	.00	.13	.48	.48	27
28	.45	.64	.54	.43	.76	.11	4.03	.26	3.80	.06	.45	.52	28
29	.46	4.71	.53	.46	.84	3.95	.02	.28	.82	3.90	.37	.47	29
30	.48		.52	3.42	.98	.93	.05	.24	.88	.83	3.35	.48	30
31	4.47		4.52		3.99		3.93	3.91		.87		3.40	31
mean	4.32	4.44e	4.60e	4.02	3.76*	3.98	3.97	4.26	3.89	4.01	3.50	3.57	mean
max.	4.51	4.71	4.75e	4.52	4.11	4.32	4.22	4.41	4.23	4.35	3.82	3.98	max.
min.	3.97	4.32	4.52	3.41	3.42	3.67	3.53	3.91	3.46	3.69	3.35	3.32	min.

yearly maximum
4.75e - March 1

yearly minimum
3.32 - December 8

remarks: Bristol Recording Gauge
Add 180.00 to obtain elevation referred to C.G.D.
e = estimated N.R. - no record
* partial mean
Obs. C.R. Hudson

/ daily mean elevation in metres
daily mean discharge in m³/s
daily mean outflow in m³/s

/ of
from LAKE HELEN
at or near Steamboat Ba

lake
river

year 19 80

NIPIGON RIVER

Hydraulic Studies Department

annual daily mean elevation(metres) or discharge(m³/s)

day	jan.	feb.	mar.	apr.	may	june	july	aug.	sep.	oct.	nov.	dec.
1	3.28	3.93	3.89	4.10	4.08	3.51	3.50*	3.99	3.69	3.67	3.32	3.35
2	N.R.	4.08	.99	.08	.13	.69	.27	.86	.65	.76	.34	.34
3	N.R.	.13	4.08	.13	.20	.67	26	3.88	.64	.69	.38	.34
4	N.R.	.15	.08	.19	.15	.73	73	4.01	.64	.61	.34	.34
5	N.R.	.15	.10	.14	.08	.77	94	4.01	.67	.64	.32	.34
6	3.69*	.13	.12	.09	.06	.81	4.12	3.89	.68	.65	.31	.34
7	.65	.12	.12	.15	.08	.74	10	84	.69	.55	.38*	.33
8	.68	.13	.13	.12	.14	.72	16	69	.58	.60	N.R.	.32
9	.83	.14	.11	.14	.16	.79	19	58	.56	.59		.31
10	.72	4.15	3.99	4.08	4.08	3.87	22	63	3.56	3.51	N.R.	3.31
11	.78	.13	.95	.15	.09	.99	18	71	.61	.35	3.46*	.32
12	.85	.16	4.05	.08	3.99	4.03	16	70	.66	.30	48	.34
13	.83	.18	.06	.10	.87	.05	18	75	.56	.32	47	.33
14	.89	.15	.09	.10	.82	.15	14	75	.57	.35	46	.31
15	.94	.12	.07	.17	.93	.20	17	73	.64	.34	46	.30
16	4.09	.19	.11	.12	4.01	.08	11	61	.74	.35	44	.29
17	.00	.19	.14	.12	3.87	3.97	03	59	.90	.53	44	.29
18	3.64	.19	.15	.15	.65	4.04	3.94	60	4.05	.35	41	.29
19	.67	.01	.14	.06	.72	.07	82	65	.07	.35	42	.30
20	.81	4.05	.08	3.63	3.93	.08	77	3.83	3.99	3.45	39	3.33
21	.89	3.93	3.96	.95	4.07	.04	79	97	.97	.50	34	.33
22	.89	.85	.93	4.05	.12	.04	72	86	4.08	.53	33	.31
23	.88	4.03	.95	.11	.03	.07	64	68	3.96	.70	33	.30
24	.83	.19	4.05	.20	3.94	.11	69	61	.89	.54	35	.31
25	.71	.21	.06	.11	4.07	.09	67	58	.76	.76	3.35	.31
26	.66	.13	.01	.09	.19	.16	59	57	.66	.66	.35	.32
27	.93	.09	3.89	.11	.08	.09	3.63	56	.60	.65	.31	.32
28	4.05	4.06	.89	.12	3.91	.02	75	56	.56	.54	.30	.31
29	.00		.98	.14	.78	.03	80e	56	.58	.58	.33	.31
30	.02		4.04	4.10	.62	3.93*	81	56	3.64	.49	3.34	.27
31	4.01		4.05		3.44		3.97	3.60		3.39		3.22
mean	3.82*	4.11	4.04	4.10	3.98	3.95	3.87e	3.72	3.73	3.52	3.38*	3.31
max.	4.09	4.21	4.15	4.20	4.20	4.20	4.22	4.01	4.08	3.76	3.48	3.35
min.	3.28	3.85	3.89	3.63	3.44	3.51	3.26	3.56	3.56	3.30	3.30	3.22

yearly maximum

4.22 - July 10

yearly minimum

3.22 - Dec. 31

comments: Bristol Recording Gauge.

Add 180.00 m to obtain elevation referred to C.G.D.

N.R. - no record e = estimated

* - partial mean Obs. C.R. Hudson

XX daily mean elevation in metres

daily mean discharge in m³/s

daily mean outflow in m³/s

XX at

from LAKE HELEN

at Steamboat Bay

lake / river NIPIGON RIVER

year 1981

Ontario Hydro
Hydraulic Studies Department

annual daily mean elevation(metres) or discharge(m³/s)

jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
3.20	3.25	3.21	3.19	3.33	3.51	3.45	4.19	3.73	3.96	4.36	4.34
.21	.25	.20	.19	.34	.63	.48	.08	.70	.90	.33	.36
.21	.23	.20	.18	.35	.69	.48	3.82	.62	.82	.31	.38
.19	.24	.21	.35	.37	.68	.48	.72	.81	.77	.28	.39
.21	.24	.21	.43	.36	.54	.50	.77	.87	.86	.27	.39
.21	.25	.20	.34	.36	.48	.55	.72	.88	.83	.29	.38
.20	.25	.20	.27	.38	.50	.57	.65	.80	.84	.30	.37*
.23	.26	.22	.24	.36	.49	.57	.62	.71	.86	.30	N.R.
.28	.25	.23	.23	.31	.49	.55	.62	.78	.79	.31	N.R.
3.43	3.24	3.22	3.22	3.29	3.48	3.53	3.69	3.84	3.71	4.35	N.R.
.65	.24	.21	.20	.34	.48	.50	.69	.89	.76	.37	N.R.
.57	.26	.23	.20	.32	.46	.52	.69	.80	.87	.31	N.R.
.47	.26	.26	.21	.29	.47	.54	.73	.76	.91	.31	N.R.
.38	.24	.23	.20	.29	.47	.52	.71	.78	.91	.33	4.36#
.32	.24	.24	.20	.31	.45	.53	.63	.81	4.05	.35	N.R.
.29	.26	.24	.21	.29	.46	.63	.62	.86	.17	.37	N.R.
.27	.25	.23	.23	.30	.45	.75	.68	.86	.22	.36	N.R.
.26	.25	.22	.21	.43	.45	.64	.68	N.R.	.22	.36	N.R.
.26	.25	.21	.20	.50	.46	.60	.63	N.R.	.16	.38	N.R.
N.R.	3.25	3.21	3.21	3.54	3.46	3.65	3.58	N.R.	4.22	4.38	N.R.
N.R.	.25	.21	.34	.52	.45	.73	.57	N.R.	.27	.44	4.33*
N.R.	.20	.19	.35	.49	.46	.75	.56	3.77	.32	.44	.33
N.R.	.20	.20	.30	.48	.48	.76	.56	.79	.34	.40	.34
N.R.	.20	.21	.24	.47	.51	.71	.58	.80	.37	.38	.34
N.R.	.21	.18	.24	.49	.48	.65	.67	.85	.39	.36	.33
3.27*	.20	.16	.25	.48	.47	.61	.71	.90	.40	.36	.33
.28	.20	.17	.26	.48	.48	.60	.71	.85	.39	.37	.35
.25	3.20	.19	.28	.47	.47	.65	.74	.89	.38	.36	.33
.24		.18	.30	.47	.46	.75	.74	4.00	.40	.36	.15
.23		.18	3.31	.46	3.45	.75	.76	.04	.39	4.33	4.12*
3.24		3.19		3.47		4.06	3.75		4.37		N.R.
3.29*	3.24	3.21	3.25	3.40	3.49	3.61	3.71	3.82*	4.09	4.35	4.33*
3.65	3.26	3.26	3.43	3.54	3.69	4.06	4.19	4.04	4.40	4.44	4.39
3.19	3.20	3.16	3.19	3.29	3.45	3.45	3.56	3.62	3.71	4.27	4.12

yearly maximum
4.44 Nov. 21 & 22

yearly minimum
3.16 Mar. 26

remarks
Bristol Recording Gauge
Add 180.00 to obtain elevation
in metres referred to C.G. Datum
*Partial Mean
N.R. No Record
Spot Reading by Manual Gauge

X daily mean elevation in metres
daily mean discharge in m³/s

X of
from
LAKE HELEN

lake
river

year 19 82

annual daily mean elevation(metres) discharge(m^3/s)

day	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
1	N.R.	4.40	4.33	4.25	4.16	3.89	3.91	3.60	3.64	3.61	4.19	N.R.
2	N.R.	.38	.31	.23	.13	.92	.80	.59	.64	.57	.18	
3	N.R.	.39	.30	.21	.20	.87	.81	.59	.64	.61	.17	
4	4.35*	.48	.30	.20	.23	.71	.86	.60	.63	.91	.16	
5	30	.48	.30	.20	.23	.66	.85	.62	.62	4.05	.17	N.R.
6	32	.47	.26	.21	.17	.72	.78	.63	.63	.07	.17	4.19*
7	33	.47	.27	.20	.13	.79	.80	.63	.65	.11	.18	.20
8	34	.40	.28	.20	.09	.74	.64	.63	.65	.13	.18	.22
9	36	.21	.26	.22	.10	.78	.35	.65	.80	.15	.17	.20
10	4.36	4.16	4.26	4.24	4.13	3.80	3.33	3.67	3.83	.17	4.16	.17
11	35*	.34	.27	.25	.12	.73	.43	.67	.71	.20	.16	.17
12	N.R.	.43	.29	.21	.12	.69	.67	.68	.69	.19	.16	.17
13	N.R.	.46	.29	.15	.15	.82	.70	.66	.66	.16	.11	.17
14	N.R.	.47	.30	.12	.09	.76	.66	.63	.62	3.99	.08	.14
15	N.R.	.42	.30	.12	3.86*	.72	.67	.62	.65	4.04	.11	4.12
16	N.R.	.24	.29	.12	N.R.	.70	.67	.64	.62	.18	.14	.15
17	N.R.	.19	.27	.12	3.87*	.69	.64	.63	.58	.24	.16	.16
18	4.53*	.24	.27	.13	.94	.94	.64	.63	.61	.24	.17	.16
19	46	.28	.26	.14	.91	4.15	.63	.65	.59	.24	.17	.18
20	40	4.30	4.25	4.14	4.07	.08	3.62	3.62	3.59	4.19	4.14	.22
21	37	.30	.26	.14	3.91	.23	.62	.63	.57	.21	.19	.22
22	37	.31	.27	.14	.75	.36	.63	.64	.55	.16	.19	.21
23	30	.28	.27	.15	.68	.24	.62	.64	.56	.17	.20	.18
24	19	.28	.27	.13	.67	.08	.60	.65	.56	.21	.30	.18
25	3.97	.28	.28	.24	.72	.13	.60	.64	.54	.22	.31	4.20
26	92	.32	.28	.24	.82	3.98	.64	.64	.54	.19	.27	.20
27	4.11	.33	.27	.24	.88	.84	.65	.63	.56	.15	.23	.20
28	32	4.32	.26	.27	.86	.86	.65	.63*	.58	.16	.17	.18
29	39		.28	.30	.77	.89	.64	N.R.	.57	.20	.05*	.18
30	39		.27	4.28	.81	.96	.61	.78*	3.59	.19	N.R.	.19
31	4.40		4.26		.88		3.61	3.67		4.18		4.19
mean	--	4.34	4.28	4.19	3.98*	3.89	3.66	3.64*	3.62	4.10	4.17*	4.18*
max.	4.40	4.48	4.33	4.30	4.23	4.36	3.91	3.78	3.83	4.24	4.31	4.22
min.	3.92	4.19	4.25	4.12	3.67	3.66	3.33	3.59	3.54	3.57	4.05	4.12

yearly maximum

4.48 - Feb. 4 & 5

yearly minimum

3.33 - July 10

remarks: Bristol Recording Gauge. Add 180.00m to obtain elevation referred to C.G. Datum.

N.R. - no record

* Partial mean

[X] daily mean elevation in metres

[ ] daily mean discharge in m^3/s

[ ] daily mean outflow in m^3/s

[X] of
[ ] from LAKE HELEN

[ ] lake
[ ] river

year 1983

at or near Steamboat Bay

NIPIGON RIVER

Ontario Hydro
Hydraulic Studies Department

annual daily mean elevation(metres) or discharge(m^3/s)

day	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
1	4.08	4.33	4.17	4.17	3.96	3.93	4.09	4.40	4.33	4.16	4.17*	4.22
2	.00	.31	.19	.17	.95	.95	13	.41	.25	.12	.19	.20
3	.07	.31	.16	.16	.95	.94	19	.41	.24	.12	.23	.18
4	.15	.30	.15	.16	.96	.93	23	.40	.25	.16	.22	.18
5	.17	.30	.14	.19	.97	N.R.	23	.40	.25	.19	.14	.16
6	.20	.36	.15	.20	.94		26	.40	.25	.21	.01	.15
7	.20	.37	.16	.16	.87		37	.39	.24	.20	3.98	.20
8	.22	.37	.22	.15	.98		38	.43	.23	.18	.99	.16
9	.22	.36	.27	.14	.96		43	.45	.22	.18	.99	3.97
10	4.22	4.35	4.20	4.17	3.94		N.R.	4.44	4.23	4.19	4.09	.99
11	.23	.33	.20	.23	.93			.36	.24	.20	.15	4.06
12	.25	.29	.27	.24	.90	N.R.		.30	.25	.20	.18	3.98
13	.28	.29	.23	.20	.90	3.96*		.29	.24	.20	.19	.97
14	.32	.27	.10	.18	.90	93		.39	.25	.19	.20	.84
15	.31	.24	.05	.23	.90	95	N.R.	.40	.26	.19	.20	.81
16	.30	.20	.17	.30	.90	99	45*	.35	.23	.10	.19	.82
17	.29	.19	.26	.24	.91	98	45	.39	.22*	.11	.19	.95
18	.29	.18	.21	.23	.92	4.00	41	.40	.22*	.10	.18	4.02
19	.26	.16	.19	.24	.89	11	43	N.R.	.18	.10	.19	.09
20	4.29	4.16	4.17	4.24	3.87	12	43	N.R.	4.16	4.23	4.19	.22
21	.34	.17	.15	.27	.87	08	44	4.42*	.19	.22	.20	.07
22	.39	.16	.12	.24	.88	19	43	.38	.23	.23	.20	.00
23	.37	.15	.10	.22	.90	25	39	.38	.21	.21	.21	.15
24	.39	.12	.11*	.21	.91	24	38	.39	.25	N.R.	.22	.02
25	.33	.12	N.R.	.16	.90	22	4.38	.37	.34		.22	3.84
26	.29	.13	N.R.	3.95	.90	21	40	.35	.27		.22	.81
27	.34	.14	.20*	.99	.94	18	43	.34	.24		.21	.92
28	.37	.13	.20	.97	.96	16	44	.38	.24		.23	.92
29	.40	4.14	.20	.88	.96	18	43	.37	.24		.23	.91*
30	.40		.18	3.89	.96	4.20	41	.35	4.23		4.23	N.R.
31	4.33		4.17		3.93		4.42	4.37		N.R.		N.R.
mean	4.27	4.24	4.18*	4.16	3.92	4.08*	4.36*	4.38*	4.24	4.17*	4.17	4.03*
max.	4.40	4.37	4.27	4.30	3.98	4.25	4.45	4.45	4.34	4.23	4.23	4.22
min.	4.00	4.12	4.05	3.88	3.87	3.93	4.09	4.29	4.16	4.10	3.98	3.81

yearly maximum
4.45 - July 16, 17 & Aug. 9

yearly minimum
3.81 - December 15 & 26

remarks
Bristol Recording Gauge. Add 180.00m to obtain elevation referred to C.G. Datum.
* Partial Mean N.R. No Record

X daily mean elevation in metres
daily mean discharge in m^3/s
daily mean outflow in m^3/s

X of / from LAKE HELEN — lake / river

at or near Steamboat Bay

NIPIGON RIVER

year 1984

annual daily mean elevation(metres) or discharge(m³/s)

N.R.	4.33	4.31	4.03	3.66	4.07	3.86	4.32	4.62	N.R.	4.77	4.98*
N.R.	N.R.	.31	.03	.56	3.92	.83	.44	.61		.78	N.R.
4.03*	N.R.	.31*	.01	.66	4.00	.85	.42	.45		.78	N.R.
.03	N.R.	.35e	3.98	.92	.16	.86	.38*	.37		.77	5.03
.05	4.36*	.39*	4.01	4.21	.20	.86	N.R.	.41		.77	4.99
.08	.34	.40	.03	.17	.17	.74	N.R.	.56		.76	.97
.09	.31	.42	.08	.25	.23	.58	N.R.	.61	N.R.	.75	.96
.07	.33	.42	.09	.28	.25	.67	4.53*	.61	5.13e*	.73	.95
.12	.35	.40	.06	.30	.24	.99	.56	.58	.13e	.71	.96
4.14	4.36	4.39	4.10	.19	4.17	4.12	.58	4.57	.12e	4.69	4.97
.17	.34	.39	.12	3.96	.14	.21	.59	.58	.11e	.68	.97
.19	.36	.38	.18	.75*	.15	.26	.62	.56	.11e	.70e	.96
.22	.43	.38*	.17	N.R.	.17	.18	.65	.58	.10e	N.R.	.96
.18	.46	N.R.	.17	N.R.	.19	.14	.65	.58	.09e		N.R.
.20	.49		.09	N.R.	.20	.14	.63	.53	.09e		N.R.
.18	.50		.00	N.R.	.20	.08	.63	.52	.04e		N.R.
.16	.47		.09	N.R.	.21	.03	.64	.50	.05e		4.95
.16	.44		.15	N.R.	.14	.02	.66	.38	.10e		.92
.17	.42		.05	N.R.	.09	3.99	.65	.35	.07e	N.R.	.75
4.23	4.39		4.03	N.R.	4.10	.90*	4.64	4.37	5.08e	5.00	.67
.28	.36		.06	N.R.	.19	N.R.	.63	.38	.08e	4.99	.65
.30	.35		.06	3.87*	.25	N.R.	.62	.38	.08e	.99	.65
.36	.35		.05	.80	.23	4.16*	.62	.40	.10e	.99	.63
.35	.33		.03	.78	.23	.20	.61	.64	.08e	5.00	.67
.35	.32	N.R.	.02	.75	.23	.25	N.R.	.80	.08e	4.99	4.67
.38	.31	4.19*	.04	.64	.25	.17	N.R.	.78	.08e	5.00	.67
.36	.31	.18	.05	.58	.33	.04	4.59*	.92	.06e	4.99	.66
.35	4.32	.17	.04	.64	.30	3.97	.59	5.03	.06e	.98	.67
.35		.19	.05	.73	3.99	4.02	.60	N.R.	.08e	5.00	.67
.31		.11	3.95	.77	.90	.06	.58	N.R.	4.98e	.00	.66
4.33		4.05		3.90		.16	4.59		.81		4.66
4.21*	4.37*	4.30*	4.06	3.88*	4.16	4.01*	4.58*	4.56*	5.07e*	4.86*	4.82*
4.38	4.50	4.42	4.18	4.30	4.33	4.26	4.66	5.03	5.13e*	5.00	5.03
4.03	4.31	4.05	3.95	3.56	3.90	3.58	4.32	4.35	4.81	4.68	4.63

Bristol Recording Gauge. Add 180.00m to obtain elevation referred to C.G.Datum

5.13e - Oct. 8 & 9

N.R. - no record

e - Estimated

3.56 - May 2

* partial mean

X

X

1985

LAKE HELEN

Steamboat Bay

NIPIGON RIVER

LAKE HELEN
AT STEAMBOAT BAY

DAILY MEAN ELEVATION IN METRES
YEAR 1986

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	184.64	184.75	184.67	184.61	184.24	184.30	184.24	184.47	184.33	184.06	183.91	N.R.	1
2	184.63	184.75	184.66	184.60	184.32	184.30	184.28	184.49	184.32	184.06	183.84	N.R.	2
3	184.63	184.72	184.65	184.58	N.R.	184.31	184.16	184.50	184.32	184.05	183.84	184.17	3
4	184.64	184.71	184.65	184.55	|	184.29	184.19	184.50	184.32	N.R.	183.82	184.16	4
5	184.65 e	184.66	184.60	184.57	|	184.27	184.39	184.43	184.33	|	183.84	184.17	5
6	184.71 e	184.63	184.60	184.58	|	184.20	184.49	184.35	N.R.	|	183.82	184.11	6
7	184.77 e	184.66	184.65	184.60	N.R.	184.22	184.50	184.32	|	N.R.	183.80	184.01	7
8	184.73	184.67	184.68	184.61	184.21	184.21	184.48	184.34	|	184.10	183.87	184.03	8
9	184.68	184.66	184.67	184.59	184.19	184.27	184.43	N.R.	N.R.	N.R.	183.86	184.11	9
10	184.68	184.66	184.66	184.50	184.15	184.29	184.26	|	184.16	|	183.84	184.13	10
11	184.66	184.66 e	184.65	184.25	184.10	184.31	184.19	|	184.09	|	183.85	184.12	11
12	184.67	184.66 e	184.65	184.12	184.12	184.38	184.19	|	184.09	|	183.83	184.12	12
13	184.68 e	184.66 e	184.64	184.14	184.21	184.37	184.22	|	184.14	|	183.83	184.10	13
14	184.68 e	184.66 e	184.64	184.17	184.19	184.29	184.24 e	|	184.18	|	184.02	184.08	14
15	184.69	184.65 e	184.64	184.17	184.23	184.27	184.32 e	|	184.20	|	184.03	184.09	15
16	184.68	184.65 e	184.64	184.20	184.24	184.27	184.40 e	|	184.20	|	183.94	184.09	16
17	184.69	184.65 e	184.63	184.23	184.28	184.30	184.46	|	184.22	|	183.96	184.08	17
18	184.67	184.65 e	184.62 e	184.23	N.R.	184.29	184.50	|	184.10	|	184.03	184.09	18
19	184.66	184.65	184.62 e	184.21	|	184.26	184.46	|	184.04	|	184.10	184.11	19
20	184.65	184.65	184.62 e	184.20	|	184.26	184.44	|	184.03	|	184.11	184.08	20
21	184.65	184.66	184.62 e	184.18	N.R.	184.28	184.42	|	184.04	N.R.	184.14	184.07	21
22	184.66	184.67	184.62 e	184.26	184.31	184.29	184.30	|	184.06	184.10	184.09	184.09	22
23	184.66	184.66	184.62 e	184.31	184.26	184.30	184.23	|	184.06	184.08	184.04	184.07	23
24	184.67	184.66	184.62 e	184.34	184.22	184.31	184.22	|	184.08	184.09	184.10	184.06	24
25	184.69	184.67	184.61 e	184.30	184.13	184.31	184.23	|	184.09	184.08	184.30	184.02	25
26	184.67	184.66	184.61	184.42	184.07	184.31	184.37	N.R.	184.12	184.08	184.27	184.00	26
27	184.73	184.65	184.59	184.35	184.05	184.36	184.44	184.33	184.11	183.99	184.20	184.01	27
28	184.77	184.66	184.61	184.31	184.06	184.35	184.45	184.35	184.06	183.91	184.10	184.00	28
29	184.77		184.60	184.34	184.03	184.33	184.45	184.33	184.04	183.86	184.07	183.99	29
30	184.76		184.60	184.28	184.15	184.22	184.46	184.33	184.00	183.86	N.R.	183.99	30
31	184.75		184.60		184.24		184.46	184.33		183.82		184.01	31
Mean	184.69	184.67	184.63	184.36		184.29	184.35						Mean
Max	184.77	184.75	184.68	184.61	184.32	184.38	184.50	184.50	184.33	184.10	184.30	184.17	Max
Min	184.63	184.63	184.59	184.12	184.03	184.20	184.16	184.32	184.32	183.86	183.80	183.80	Min

SUMMARY FOR THE YEAR 1986

-Mean -
-Maximum daily - 184.77
-Minimum daily - 183.80

e - estimated
N.R. - no record

Bristol Recording Gauge.
Remarks: Monthly/Annual mean only included if all daily means are available.

ONTARIO HYDRO
GEOTECHNICAL AND HYDRAULIC ENGINEERING DEPARTMENT

LAKE HELEN
AT STEAMBOAT BAY

DAILY MEAN ELEVATION IN METRES
YEAR 1987

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	183.90	184.14	183.96	184.04	183.52	183.30	183.27	183.42	183.33	183.96	183.47	183.44	1
2	183.88	184.14	183.96	184.04	183.35	183.32	183.30	183.75	183.32	183.87	183.39	183.43	2
3	183.96	184.13	184.03	184.06	183.27	183.30	183.33	183.72	183.35	183.86	183.38	183.46	3
4	183.98	184.10	183.99	184.10	183.25	183.29	183.44	183.71	183.38	183.67	183.38	183.74	4
5	184.02	184.07	183.98	184.10	183.26	183.30	183.36	183.45	183.53	183.45	183.28	183.47	5
6	184.02	183.98	183.97	184.08	183.31	183.30	183.43	183.42	183.49	183.34	183.40	183.32	6
7	184.01	183.93	183.97	184.07	183.27	183.29	183.53	183.45	183.41	183.39	183.34	183.30	7
8	184.02	183.91	183.95	184.08	183.25	183.26	183.66	183.47	183.41	183.57	183.27	183.34	8
9	184.04	183.93	183.99	184.08	183.24	183.26	183.77	183.56	183.45	183.55	183.28	183.38	9
10	N.R.	183.92	184.08	184.05	183.24	183.28	183.57	183.48	183.44	183.44	183.59	183.34	10
11	|	183.90	184.01	184.02	183.23	183.29	183.48	183.42	183.59	183.36	183.56	183.29	11
12	|	183.92	183.95	184.00	183.25	183.30	183.61	183.49	183.82	183.49	183.38	183.30	12
13	N.R.	183.97	183.93	184.01	183.23	183.30	183.55	183.60	183.71	183.72	183.35	183.44	13
14	184.01	183.99	183.92	184.00	183.22	183.29	183.37	183.62	183.55	183.76	183.27	183.34	14
15	184.01	183.99	183.92	183.97	183.23	183.29	183.32	183.74	183.53	183.89	183.26	183.31	15
16	184.07	184.01	183.92	183.91	N.R.	183.29	183.33	183.74	183.47	184.00	183.28	183.36	16
17	184.08	184.00	183.94	183.87	|	183.29	183.43	183.58	183.40	183.87	183.26	183.27	17
18	184.05	184.00	183.97	183.83	|	183.30	183.63	183.46	183.39	183.73	183.25	183.28	18
19	184.04	183.99	183.99	183.83	N.R.	183.28	183.72	183.44	183.39	183.62	183.26	183.27	19
20	184.06	183.98	183.99	183.79	183.23	183.28	183.65	183.45	183.51	183.64	183.29	183.26	20
21	184.09	183.97	183.99	183.82	183.24	183.30	183.45	183.45	183.66	183.70	183.42	183.25	21
22	184.08	183.95	183.99	183.90	183.34	183.29	183.39	183.65	183.76	183.62	183.36	183.25	22
23	184.24	183.94	183.99	183.91	183.29	183.30	183.38	N.R.	183.70	183.59	183.32	183.25	23
24	184.48	183.95	184.00	183.92	183.29	183.32	183.38	|	183.62	183.50	183.28	183.23	24
25	184.51	183.95	183.99	N.R.	183.29	183.35	183.45	|	183.52	183.56	183.41	183.24	25
26	184.47	183.95	183.98	|	183.29	183.36	183.42	|	183.56	183.61	183.56	183.25	26
27	184.41	183.98	183.97	|	183.29	183.30	183.39	N.R.	183.51	183.50	183.54	183.23	27
28	184.37	183.98	183.97	|	183.29	183.29	183.35	183.38	183.44	183.45	183.61	183.23	28
29	184.28		183.99	N.R.	183.29	183.25	183.40	183.38	183.53	183.36	183.39	183.40	29
30	184.23		184.05	183.54	183.29	183.25	183.46	183.42	183.68	183.50	183.28	183.86	30
31	184.19		184.05		183.30		183.37	183.37		183.67		183.94	31
Mean		183.99	183.98			183.29	183.46		183.52	183.82	183.37	183.37	Mean
Max	184.51	184.14	184.08	184.10	183.52	183.36	183.77	183.75	183.82	184.00	183.61	183.94	Max
Min	183.88	183.90	183.92	183.54	183.22	183.25	183.30	183.38	183.32	183.34	183.25	183.23	Min

SUMMARY FOR THE YEAR 1987

-Mean - 183.62
-Maximum daily - 184.51
-Minumum daily - 183.22

N.R. - no record

Bristol Recording Gauge.
Remarks: Monthly/Annual mean only included if all daily means are available.

ONTARIO HYDRO
GEOTECHNICAL AND HYDRAULIC ENGINEERING DEPARTMENT

Appendix 2C

1991 and 1992 Lake Nipigon Water Level at Macdiarmid

	J	F	M	A	M	J	J	A	S	O	N	D
1.00	259.657	259.617	259.607	259.410	259.440	259.787	259.933	259.990	259.885	259.775	259.707	259.668
2.00	259.657	259.612	259.497	259.408	259.462	259.812	259.928	259.990	259.880	259.780	259.717	259.663
3.00	259.660	259.613	259.488	259.403	259.482	259.827	259.937	259.987	259.878	259.770	259.730	259.665
4.00	259.657	259.613	259.487	259.400	259.495	259.838	259.947	259.982	259.873	259.777	259.727	259.663
5.00	259.648	259.610	259.492	259.397	259.505	259.838	259.957	259.976	259.867	259.763	259.730	259.658
6.00	259.645	259.600	259.493	259.402	259.517	259.838	259.963	259.967	259.858	259.762	259.720	259.648
7.00	259.645	259.595	259.488	259.407	259.528	259.840	259.963	259.963	259.855	259.760	259.713	259.646
8.00	259.642	259.592	259.482	259.410	259.538	259.842	259.965	259.962	259.855	259.765	259.703	259.643
9.00	259.637	259.590	259.478	259.405	259.540	259.845	259.968	259.962	259.852	259.765	259.703	259.650
10.00	259.637	259.583	259.478	259.400	259.543	259.848	259.975	259.960	259.846	259.762	259.707	259.653
11.00	259.637	259.577	259.475	259.393	259.548	259.852	259.980	259.960	259.833	259.760	259.707	259.657
12.00	259.637	259.570	259.472	259.390	259.553	259.860	259.985	259.958	259.827	259.767	259.695	259.655
13.00	259.635	259.567	259.465	259.385	259.563	259.865	259.987	259.957	259.822	259.753	259.688	259.653
14.00	259.636	259.562	259.458	259.383	259.575	259.877	259.988	259.953	259.822	259.755	259.688	259.647
15.00	259.632	259.558	259.455	259.383	259.590	259.882	259.987	259.952	259.822	259.748	259.698	259.638
16.00	259.630	259.557	259.453	259.382	259.603	259.892	259.990	259.952	259.815	259.752	259.697	259.632
17.00	259.633	259.547	259.455	259.388	259.607	259.895	259.993	259.947	259.815	259.757	259.690	259.633
18.00	259.640	259.542	259.453	259.390	259.605	259.903	259.995	259.938	259.818	259.752	259.690	259.637
19.00	259.642	259.537	259.448	259.395	259.603	259.900	259.997	259.927	259.823	259.743	259.690	259.640
20.00	259.643	259.543	259.443	259.392	259.606	259.898	259.997	259.923	259.820	259.723	259.692	259.640
21.00	259.643	259.543	259.440	259.392	259.615	259.893	259.995	259.922	259.813	259.722	259.692	259.640
22.00	259.645	259.537	259.440	259.392	259.620	259.895	259.995	259.918	259.815	259.715	259.695	259.640
23.00	259.643	259.528	259.438	259.395	259.623	259.895	259.997	259.912	259.805	259.712	259.700	259.640
24.00	259.640	259.522	259.430	259.398	259.642	259.896	259.995	259.905	259.793	259.710	259.698	
25.00	259.638	259.520	259.427	259.398	259.663	259.902	259.993	259.905	259.787	259.710	259.693	
26.00	259.637	259.520	259.427	259.393	259.688	259.915	259.992	259.903	259.790	259.707	259.687	
27.00	259.635	259.518	259.428	259.395	259.698	259.915	259.993	259.908	259.788	259.707	259.678	
28.00	259.630	259.513	259.428	259.398	259.717	259.920	259.993	259.910	259.780	259.695	259.678	
29.00	259.623		259.422	259.410	259.738	259.923	259.990	259.912	259.775	259.702	259.678	
30.00	259.622		259.418	259.422	259.757	259.933	259.988	259.903	259.783	259.695	259.675	
31.00	259.618		259.412		259.772		259.988	259.893		259.703		

1991 DATA

MONTH						1992	DATA						
30-Dec-91		J	F	M	A	M	J	J	A	S	O	N	D
31-Dec-91													
01-Jan-92	1.00	259.640	259.570	259.520	259.430	259.430	259.990	260.110	260.260	260.340	260.430	260.215	260.005
02-Jan-92	2.00	259.640	259.570	259.520	259.430	259.440	260.000	260.105	260.230	260.340	260.430	260.205	260.000
03-Jan-92	3.00	259.640	259.570	259.510	259.420	259.440	260.020	260.110	260.220	260.355	260.435	260.190	260.000
04-Jan-92	4.00	259.640	259.560	259.510	259.420	259.450	260.005	260.125	260.240	260.340	260.440	260.175	259.995
05-Jan-92	5.00	259.630	259.560	259.510	259.420	259.450	260.005	260.130	260.245	260.370	260.425	260.185	259.975
06-Jan-92	6.00	259.630	259.560	259.500	259.410	259.460	260.030	260.130	260.235	260.380	260.415	260.180	259.985
07-Jan-92	7.00	259.630	259.560	259.500	259.410	259.470	260.035	260.135	260.245	260.360	260.410	260.155	259.975
08-Jan-92	8.00	259.630	259.560	259.500	259.410	259.480	260.045	260.155	260.260	260.355	260.415	260.155	259.965
09-Jan-92	9.00	259.630	259.560	259.500	259.410	259.500	260.045	260.160	260.260	260.365	260.390	260.150	259.970
10-Jan-92	10.00	259.620	259.560	259.490	259.400	259.510	260.050	260.160	260.260	260.380	260.380	260.145	259.970
11-Jan-92	11.00	259.610	259.560	259.490	259.400	259.560	260.065	260.170	260.270	260.390	260.380	260.130	259.970
12-Jan-92	12.00	259.610	259.560	259.490	259.400	259.580	260.070	260.180	260.260	260.400	260.360	260.130	259.960
13-Jan-92	13.00	259.610	259.560	259.480	259.400	259.630	260.050	260.175	260.250	260.410	260.355	260.130	259.965
14-Jan-92	14.00	259.600	259.560	259.480	259.400	259.640	260.070	260.195	260.250	260.420	260.345	260.110	259.965
15-Jan-92	15.00	259.600	259.560	259.480	259.390	259.670	260.070	260.195	260.250	260.440	260.345	260.095	259.965
16-Jan-92	16.00	259.600	259.560	259.480	259.390	259.690	260.060	260.205	260.250	260.450	260.330	260.090	259.965
17-Jan-92	17.00	259.590	259.550	259.480	259.390	259.720	260.065	260.210	260.240	260.455	260.322	260.080	259.960
18-Jan-92	18.00	259.590	259.550	259.480	259.380	259.760	260.090	260.215	260.240	260.470	260.310	260.075	259.945
19-Jan-92	19.00	259.590	259.550	259.470	259.380	259.790	260.090	260.225	260.245	260.465	260.305	260.065	259.950
20-Jan-92	20.00	259.590	259.540	259.470	259.380	259.805	260.095	260.230	260.255	260.465	260.300	260.070	259.950
21-Jan-92	21.00	259.590	259.540	259.470	259.380	259.830	260.090	260.235	260.260	260.460	260.305	260.065	259.945
22-Jan-92	22.00	259.580	259.540	259.460	259.390	259.850	260.090	260.235	260.250	260.490	260.290	260.065	259.930
23-Jan-92	23.00	259.580	259.540	259.460	259.410	259.870	260.090	260.245	260.250	260.440	260.285	260.065	259.900
24-Jan-92	24.00	259.580	259.540	259.460	259.410	259.900	260.095	260.240	260.290	260.435	260.295	260.035	259.900
25-Jan-92	25.00	259.580	259.530	259.460	259.410	259.920	260.095	260.235	260.300	260.440	260.285	260.035	259.900
26-Jan-92	26.00	259.580	259.530	259.460	259.410	259.935	260.095	260.245	260.300	260.440	260.270	260.030	259.880
27-Jan-92	27.00	259.580	259.530	259.440	259.420	259.945	260.095	260.220	260.300	260.445	260.255	260.020	259.880
28-Jan-92	28.00	259.580	259.520	259.440	259.420	259.960	260.085	260.225	260.305	260.460	260.245	260.020	259.880
29-Jan-92	29.00	259.580	259.520	259.440	259.420	259.970	260.100	260.240	260.320	260.435	260.235	260.005	259.870
30-Jan-92	30.00	259.580		259.440	259.420	259.980	260.100	260.215	260.331	260.450	260.230	260.010	259.890
31-Jan-92	31.00	259.570		259.430		259.990		260.240	260.340		260.225		259.905

Appendix 2D

Lake Nipigon Brook Trout Spawn-taking
Lake Nipigon Brook Trout Stocking

Source: Ritchie and Black, 1988

Appendix 4. Summary of O.M.N.R. brook trout spawn-taking operations on Lake Nipigon, 1923 to present.

		# Eggs Taken			
Year	Dates	West Bay	South Bay	Nipigon House	Total
1923	Oct.- Nov 16	-1,728,000- (617)			1,728,000 (617)
1924	Oct.3 - Nov.13	546,000 (195)		144,000 (51)	690,000 (236)
1925	N.A.	-970,000- (346)			970,000 (346)
1926	Oct.2 - Nov.13	-525,000- (188)		309,000 (110)	834,000 (298)
1927	Oct.2 - Nov 23	-685,000- (245)			685,000 (245)
1928	N.A.	-637,000- (228)			637,000 (228)
1929	Sep.30- Nov.12	834,000 (298)	282,000 (101)		1,116,000 (339)
1930	Oct.3 - Nov.10	894,000 (319)	322,000 (115)		1,266,000 (434)
1931	Sep.27- Nov.13	1,930,000 (689)	654,000 (234)		2,484,000 (923)
1932	Sep.26- Nov.17	-2,487,000- (888)			2,487,000 (888)
1933	Sep.21- Nov.17	1,668,000 (596)	525,000 (188)		2,193,000 (784)
1938	N.A.	250,000 (89)			250,000 (89)
1946	Sep.27- Nov.11		86,000 (31)		86,000 (31)
1948	Oct.12- Nov.16	297,500 (106)			297,500 (106)
1953	Oct.21- Dec.7	110,000 (39)			110,000 (39)
1954	Oct.26- Nov.9	150,000 (54)			150,000 (54)
1975	N.A.	54,000 (19)			54,000 (19)
1976	Oct.14- Oct.25	41,500 (15)			41,500 (15)
1977	Oct.16- Nov.3	91,000 (33)			91,000 (33)
1978	Oct.8 - Nov.8	92,000 (33)			92,000 (33)
1984	Oct.16- Nov.2	72,500 (23)			72,500 (23)

Numbers in brackets = approx. numbers of females stripped (based on 2800 eggs/female)

Appendix 5. Summary of brook trout stocked in Lake Nipigon since 1928. (Sources: Ritchie and Black (1988) and Nipigon District files.

Year	Date	# Stocked	Age	Location
1928		25 000	F	
1930		30 000	F	West Bay
1934		230 000	F	South & West Bay & Shakespeare
1935		100 000	F	South & West Bay
1946	Nov.	985	A	
1950		280 000	F	Windigo Bay
1952		6 000	SA	Sturgeon R.
1956	Oct.	400	A	
1975	June	1 300	A	Sturgeon R.
1976	June	1 000	A	Sturgeon R.
1983	Nov.	952	S A	South Bay
	Dec.	4 846	A	Sand River
1984	June	2 198	A	Macoun Island
	Dec.	2 500	A	Forgan L.
1986	June	2 000	S A	West Bay
	May	580	A	Russell Is.
	May	6	A	Macdiarmid
	May	170	A	Blackwater R.
	May	52	A	Naonan Is.
	May	292	A	Shakespeare Is.
	May	493	A	Mungo Point
	Nov.	1 936	A	South Bay
1987	Nov.	1 000	A	Forgan L.
1988	Nov.	530	M71	Forgan L.
	Nov.	250	M71	Forgan L.
	Nov.	342	M22	Lake Nipigon
	Nov.	607	M34	Lake Nipigon
	Nov.	1 893	M22	Lake Nipigon
	Nov.	1 097	M34	Lake Nipigon

Appendix 5. Continued

Year	Date	# Stocked	Age	Location
1988	Nov.	469	M46	Lake Nipigon
	Nov.	428	M46	Lake Nipigon
	Nov.	1 549	M22	Lake Nipigon
	Nov.	100	M46	Lake Nipigon
	Nov.	175	M34	Lake Nipigon
	Nov.	100	M46	Lake Nipigon
	Nov.	100	M34	Lake Nipigon
1989		544	M58	Forgan Lake
	Jan.	19 000	EEG	Lake Nipigon
	Nov.	900	M34	Lake Nipigon

F = fingerlings
SA = sub-adults
A = adults
M = months
EEG = eyed eggs

Appendix 3A

- "UPDATE" Newsletters
  - Fall 1992
  - Volume 2, February 1993
  - April 29, 1993
- Article in Nipigon Bay RAP Newsletter
- Public Meetings Advertisement, June 1993

NIPIGON RIVER WATERSHED MANAGEMENT PLAN STUDY

UPDATE

FALL 1992

Background

This newsletter is the first of a series to bring you information on the progress of a study to develop a Watershed Management Plan for the Nipigon River system. This publication is being distributed to those who have already become involved in the study, plus any other interested groups or individuals we have yet to meet, who have expressed their interest and/or concern with fluctuating water levels along the Nipigon River system.

The study has been initiated in response to growing public concern regarding the effects of water level fluctuations on the Lake Nipigon/Nipigon River ecosystem.This two-year project is being conducted by a consulting team, headed by Atria Engineering Hydraulics Inc. of Mississauga, under the supervision of the Nipigon River Management Committee. This inter-agency Management Committee includes representatives from the Ontario Ministries of Natural Resources and the Environment, Ontario Hydro, the Nipigon Bay Remedial Action Plan (RAP) Team and the Nipigon Bay RAP Public Advisory Committee.

Scope of Study

The study area includes Lake Nipigon, the Nipigon River and Nipigon Bay, and any adjacent areas affected by the River system (Polly Lake, Lake Helen, Red Rock etc.). The purpose of the study is to recommend a preferred option for better managing the water quantity along the system. The consulting team has begun a process of data gathering, principally through interviews with those affected by the fluctuations—"stakeholders"—in order to first identify what people's main concerns are, and to hear of any proposed solutions. In addition to stakeholder interviews, the consultants are reviewing any documentation or studies which have been undertaken in the area on ecosystem-related issues. If you are interested, a list of the documents being reviewed is available. As well the consultants are undertaking a review - including field studies- of the cumulative effects of other pressures)e.g. competition with other fish, lampricides, pollution, commercial fishing, angling and log drives) on the Nipigon River fisheries. This is being done in order to assess what role fluctuating levels have played in the decline of the fisheries.

Consulting Team

Atria Engineering Hydraulics Inc. are specialists in coastal and river engineering, environmental hydraulics and hydrology. The Project Manager from Atria is Mark Kolberg. Joining Atria for the project are: Rob Turland from Ecological Services for Planning Limited (ESP) who brings a background in environmental planning and a particular knowledge of water quality and aquatic biology; David Evans and Mary Rowe, specialists in public consultation and conflict resolution; and John Nabigon, a Thunder Bay resident who brings first-hand experience working in natural resource management with First Nations communities.

Initial Stakeholder Interviews: Phase One

Since late August members of the consulting team have been meeting with various stakeholders throughout the study area, to outline the purpose of the study and to learn of how the water fluctuations have affected their use and enjoyment of the system. The consultants have met with commercial fishing operators, outfitters, cottagers, tourist operators, municipal public works officials, environmental groups, and First Nations representatives. This first phase of information gathering will continue until early December.

Initial Interview Results

The following summarizes the feedback we have received from the interviews we have conducted to date. If we have missed anything, we hope you will tell us by contacting the address below.

Fisheries disruption

People are concerned that fluctuating water levels are having an effect on the fish stocks in Lake Nipigon, Pijitawabik and Orient Bays, and through the Nipigon River to Polly Lake. Lower levels expose spawning beds and restrict access to river mouths. Prolonged higher levels erode the banks which in turn leads to the siltation of the spawning beds. Higher levels also submerge vegetation along the shoreline which decays and eventually contaminates the water.

Some people we met with see other factors having influenced the stocks such as over-fishing and the presence of smelt. In Lake Nipigon, some identified speckled trout as being significantly down in numbers, while others had not observed a significant change. However many have observed a drop in numbers of speckled trout in the river.

Impacts on Tourism

Some feel lower fish stocks are keeping tourists away, while others do not think it is that serious.

Higher water levels take away beach area that hunters use, reduce beachcombing opportunities for tourists, leave lodges with washed out docks, and again cause erosion which results an increase in siltation and shallower water at some points, and in floating logs and debris which pose hazards to boaters.

Lower water levels make access difficult particularly in the Spring, forcing some operators to store their boats further up the system over the winter in order to ensure a Spring launch.

Impact on Livelihoods and Enjoyment of System

Higher water levels has resulted in the flooding of native burial grounds and traditional hunting and fishing grounds, and infringement upon berry picking and areas where medicinal plants are found.

Camp owners particularly on Polly Lake complained that the fluctuations leave them at times with erosion concerns and no beach at all, while at others a huge beach but consequently a quick drop off so that children have no shallow water in which to swim. Other problems for Polly Lake were: an unpleasant smell-the result of rotting plant life left behind when the water level is dropped; costs of building retaining walls to stop the erosion; inability to permanently locate a dock for fear of finding boats on dry land hours later; navigational hazards and declining bait fish stocks.

Other Impacts

The increase in siltation makes it necessary to filter more often water taken by the Town of Nipigon for municipal purposes.

Also, many of the people we spoke to expressed the view that Lake Nipigon is the last of the 'Great Lakes' to be relatively undisturbed and that we should be working harder to preserve its natural state.

Next Step: Phase Two

Following completion of the data collection phase, the consulting team will compile the results of their findings and begin the second phase of the study -to develop various management options. In the early Spring, these options will be made public for discussion at a series of meetings. Subsequent issues of this publication will keep you posted on our progress and the proposed timing for those sessions.

For further information:

Thanks again to those of you who took time out of your days (and evenings) to meet with us during the last few months. You can expect this newsletter every four months. If you have any questions or comments on any aspects of the study, please contact:

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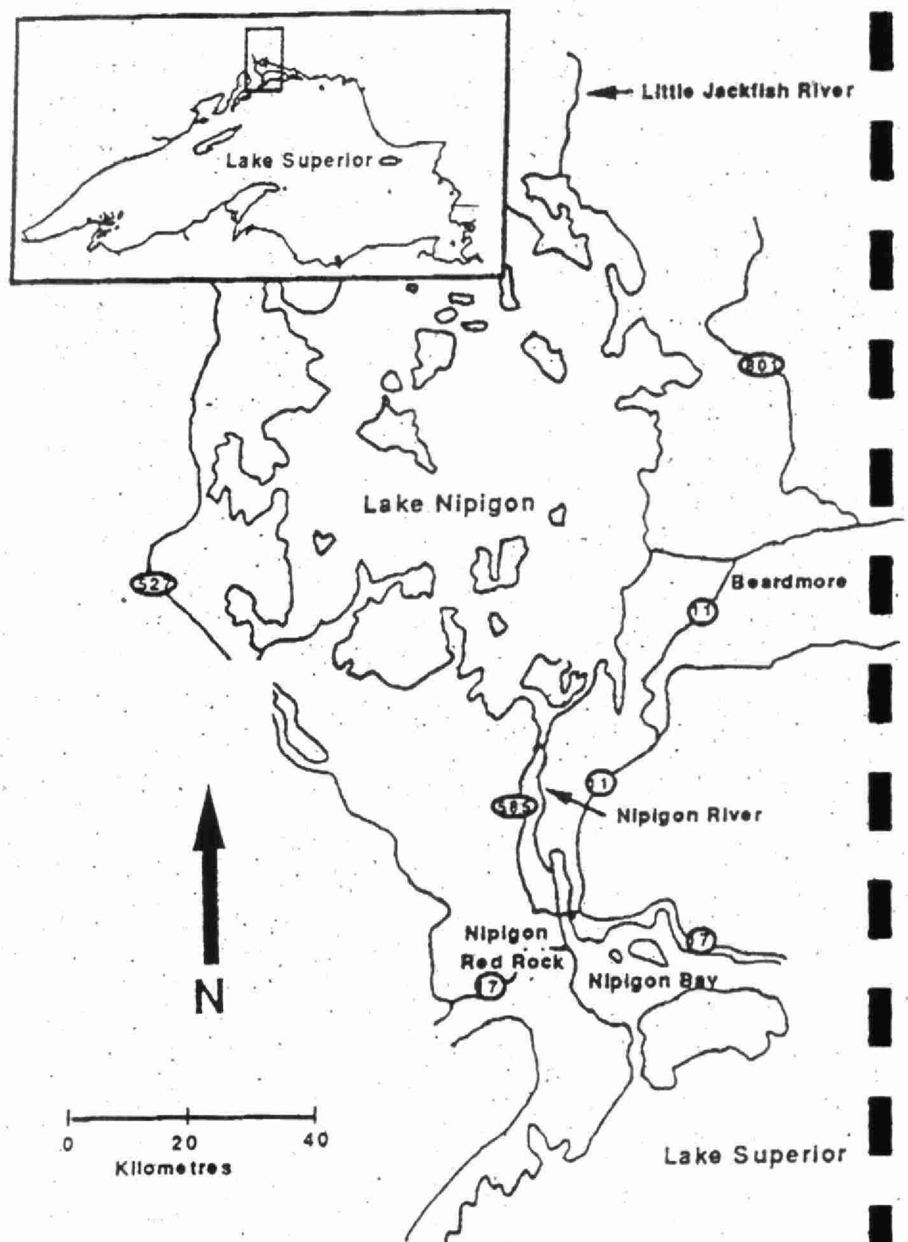
Project Manager
Nipigon River Watershed Management Study
Atria Engineering Hydraulics Inc
8 Stavebank Road North, Suite 301
Mississauga, Ontario
L5G 2T4

tel. (416) 891-0020 fax. (416) 891-0071



NIPIGON RIVER WATERSHED MANAGEMENT PLAN STUDY

UPDATE

Volume 2 • FEBRUARY 1993

Background

This newsletter is the second in a series to bring you information on the progress of a study to develop a management plan for the Nipigon River Watershed. The study was initiated in response to a growing public concern regarding the effects of water level fluctuations in the Nipigon River Watershed. This two year project is being headed by Atria Engineering Hydraulics Inc. of Mississauga under the supervision of the Nipigon River Management Committee. Ecological Services for Planning Ltd. (ESP), of Guelph, is conducting the fisheries investigation.

This update focuses on the fisheries component of the study – a concern many stakeholders raised with members of our consulting team during their visits last fall. We are distributing this publication to those who have already become involved in the study, plus any other interested groups or individuals.

Scope of the fisheries investigations

Ongoing fisheries investigations are being conducted to determine the impacts of water quantity management on the fisheries in the Nipigon River Watershed. The object of these studies is to identify alternative water quantity management practices that could potentially protect and enhance the fisheries within the system.

The focus of the fisheries portion of this study is brook trout, as they serve as a kind of "bell weather" indicator of the health of the marine ecosystem. However they are not the only fish species affected by the fluctuating water levels. We anticipate that management options designed to improve their habitat will also benefit other fish species.

History of impacts in the Watershed

The Nipigon River Watershed has supported a brook trout sport fishery since the 1800s, at which time it became known for world record-sized fish. Although still recognized as one of the premier brook trout fisheries in the world, many factors have reduced the suitability of the system as a habitat for brook trout. These, as illustrated by *Figure 1*, include:

- commercial and sport fisheries activity since the late 1800s;
- effects of construction of dams at Cameron Falls (1920), Virgin Falls (1926 – now submerged), Alexander (1930) and Pine Portage (1950), and the flooding of extensive stretches of the river;
- alteration of water levels on Lake Nipigon and water flow rates on the Nipigon River;
- log drives between 1923 and 1973;
- the introduction of exotic fish species including rainbow smelt, rainbow and brown trout, and coho, pink and chinook salmon since the 1950s;
- the use of biocides on the river to control blackfly and sea lamprey, which began in the 1960s;
- increased flow rates as a result of the Ogoki diversion in 1943;
- channel modifications including the dredging of the river between Helen Lake and Alexander, installation of highway and railway bridges, and installation of pipelines crossings; and
- degradation in water quality in Nipigon Bay as a result of municipal and pulp mill effluents.

The result of these activities has been a drastic decline in the brook trout fishery.

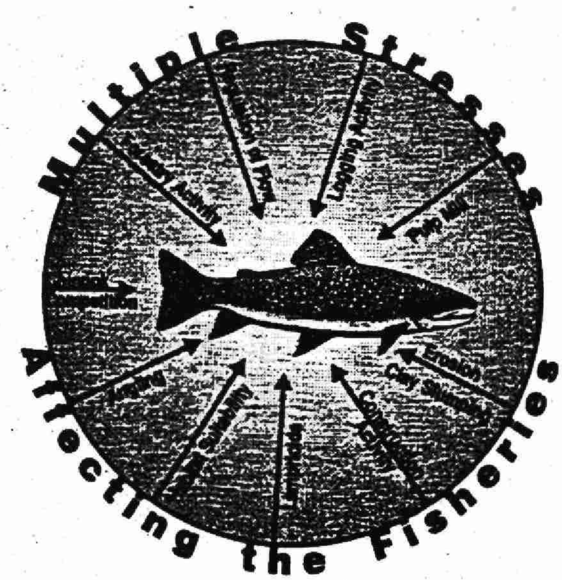


Figure 1

Water quantity management

Ontario Hydro owns and operates three hydroelectric dams on the river: Pine Portage, Cameron Falls and Alexander Falls Generating Stations (GS). Installation of the dams resulted in the flooding of large stretches of the river, and consequently drastically changed the nature of the fisheries habitat located there. Operation of the generating stations has altered natural water level fluctuations on Lake Nipigon and water flows in the downstream section of the Nipigon River.

Effects on the fisheries

When the water flows within rivers change, other variables are affected, including velocity, water depth, river width and wetted perimeter. The effects of fluctuations in flow rates are most pronounced in the portion of the Nipigon River between Alexander Falls GS and Nipigon Bay and in Helen Lake and Polly Lake. These fluctuations:

- expose brook trout redds[1] during low flow events and alter ground water flow through redds;
- exacerbate the instability of the shorelines and stream bank erosion;
- kill fish including sculpins and young salmon that are left stranded and exposed; and
- reduce the abundance and diversity of invertebrates (an important food source for fish) on substrates, which become exposed during low flow.

On Lake Nipigon, the fluctuating water level does not follow the natural fluctuation pattern that previously occurred on the lake. The water level of the lake is managed so that it peaks in the fall and gradually drops over winter. The high water levels in the fall coincide with brook trout spawning activity. The erosion and increased turbidity caused by high water levels has not only led to degradation of spawning habitat, but may have also inhibited spawning activity itself, as the visual orientation of the brook trout may have been impaired. In some years, the water level has dropped so low that brook trout spawning redds have been exposed, thus killing eggs and any fingerlings.

Next step

As you know, the scope of this study includes documenting a wide variety of resource impacts and uses of the Nipigon River Watershed. In addition to the fisheries, water fluctuations have had an effect on the livelihoods of lodge and charter boat operators and has inconvenienced and in some cases cost financially property owners along the system. The first phase of this study, now near its completion, included collecting data on the various effects of the fluctuations, and documenting the specific issues or concerns raised by the groups or individuals with whom we met. By March 31, 1993, the consulting team will have submitted their first report to the Nipigon River Management Committee. This report will provide greater detail of the issues and concerns reported to the consulting team, and will put forward several management options for consideration by the Committee and the public. These options will be discussed in the spring of this year with those individuals and organizations that have expressed an interest thus far. This subsequent phase of work will require a detailed analysis of the potential impact of each option on the fisheries, commercial and pleasure uses. You can expect to hear from us in the coming months with further details on this consultation.

Other News

Since our first newsletter, David Evans has made two additional site visits to speak with various individuals and organizations, including representatives from the First Nations affected by the Nipigon River Watershed, to ensure their concerns were being documented and considered.

For further information

If you have any questions or comments on any aspect of the study, please contact:

Mark Kolberg, P. Eng
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Telephone: (416) 891-0020 Fax: (416) 891-0071

1 A "redd" is a term that refers to where the eggs are spawned – it is like a nest.

UPDATE

April 29, 1993

NIPIGON RIVER
DEVELOPMENT OF A WATER MANAGEMENT PLAN

This update is to keep you informed on the progress of the development of a water management plan for the Nipigon River watershed. The first report, entitled the ***Draft Options Report***, is now being finalized and will be in the mail to you within two weeks.

We will be holding public meetings in Nipigon (Tuesday, June 8), Thunder Bay (Wednesday, June 9) and Beardmore (Thursday, June 10) to discuss the report. The meetings will start at 7 pm. Members of the study team will be available prior to the meetings, from 3 to 5 pm, for additional discussions. The times and locations of the meetings will be included with the report. We also plan to advertise the meetings in the local newspapers.

Attached are the terms of reference for a working group we are organizing. We will be talking about this group at the public meetings, but if you are interested in becoming a member, let us know at any time. The two members representing the Atria Engineering study team will be David Evans and Mark Kolberg. The first meeting of the working group will be Thursday, June 24, 1993, in Nipigon.

If you have any questions or require more information, please contact Mark Kolberg, Project Manager, at Atria Engineering Hydraulics Inc. (telephone (416) 891-0020).

Nipigon River Watershed Management Study

In response to public concern regarding the effects of water level fluctuations on the Lake Nipigon/Nipigon River ecosystem, a watershed management study has been initiated. A detailed evaluation is required to assess the importance of water management as it relates to aquatic habitat, sedimentation, erosion, and recreational and commercial uses in the ecosystem. The scope of the study includes Lake Nipigon, the Nipigon River and Nipigon Bay and will include extensive consultation with all stakeholders.

The project is being coordinated by the Nipigon River Watershed Management Steering Committee which was formed in 1990 and is composed of representatives from the Ministry of Natural Resources, Ontario Hydro, the Nipigon Bay RAP Team, Nipigon Bay RAP Public Advisory Committee and the Ministry of the Environment. While the Steering Committee is providing coordination for the study, the project, itself, is actually being carried out by a team of consultants headed up by Atria Engineering Hydraulics Incorporated. This team is composed of experts in the fields of public consultation, engineering and hydraulics, and environmental biology. The team anticipates to be making their first public contacts in late August.

The overall goal of the project is to establish, through extensive public consultation, a preferred option for water quantity management for Lake Nipigon and the Nipigon River. The project will be completed over a period of two years. Year one will involve confirmation with identified stakeholders of all conflicts and water uses. Management options will then be identified and evaluated from a cost-benefit perspective. The second year will have an emphasis on public consultation. The consultants will continue to meet with stakeholders and progress towards consensus building, and will hold public open houses to facilitate options discussion within the communities. The result will be a final report recommending a preferred management strategy.

The Nipigon River flows a distance of 51 km between Lake Nipigon and Nipigon Bay, and although the mean annual discharge exceeds 300 cubic metres per second, significant water level fluctuations do occur. These fluctuations are a result of the regulation of river flows for optimizing the generation of hydroelectric power. While these fluctuations fall within previously identified legal limitations and social considerations, they still have a significant effect on all stakeholders of the Lake Nipigon, Nipigon River and Nipigon Bay ecosystem.

The project team has been provided with a list of individuals and groups to be contacted for interviews. If you are a stakeholder in the area and are not certain whether you are on this list, please contact Ken Cullis, Nipigon Bay RAP Coordinator at (807) 768-1826.

Article in the Nipigon Bay RAP Newsletter

Notification Advertisement

Are you concerned about the health of the fishery in the Nipigon River Watershed?

A study team hired by the Nipigon River Management Committee has just completed a year of interviews and information gathering. The team has prepared a report that identifies some management options to address the effect fluctuating water levels are having on the fishery.

If you are interested, please come to meet members of the study team to discuss the options.

Drop In and Meeting Locations and Times

Tuesday, June 8

Royal Canadian Legion Hall Branch 32
102 5th Street
Nipigon

3- 5 p.m. Drop In - Informal Discussion
7 - 10 p.m. Presentation and Discussion

Wednesday, June 9

New Government Building, Auditorium A
189 Red River Road
Thunder Bay

3- 5 p.m. Drop In - Informal Discussion
7 - 10 p.m. Presentation and Discussion

Thursday, June 10

The Evergreen Senior Citizens Club
Main Street
Beardmore

3- 5 p.m. Drop In
7 - 10 p.m. Presentation and Discussion

For more information about the meetings or to a receive a copy of the Draft Options Report, please call Mark Kolberg collect at Atria Engineering (416) 891 - 0020

Appendix 3B

List of Nipigon Stakeholders in Contact with Study Team

Robert and Diane Cote
R&R Charters
P.O. Box 137
Beardmore, Ontario
P0T 1G0

Shirley and Clifford Sutherland
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P0T 1G0

Melvin Rentz
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Beardmore, Ontario
P0T 1G0

Harvey Rentz
P.O. Box 205
Beardmore, Ontario
P0T 1G0

Helen J. Marek
P.O. Box 128
Beardmore, Ontario
P0T 1G0

Ed Thorsteinson
P.O. Box 147
Beardmore, Ontario
P0T 1G0

Eric Rutherford
Reeve
Town of Beardmore
Beardmore, Ontario
P0T 1G0

Frank Goodman
P.O. Box 68
Beardmore, Ontario
P0T 1G0

Simon Nakanogis
Rocky Bay First Nation
Rocky Bay General Delivery
MacDiarmid, Ontario
P0T 2B0

David Rentz
P.O. Box 205
Beardmore, Ontario
P0T 1G0

Melvin Hardy
R.R. #1
Dorion-Hurkett, Ontario
P0T 1K0

Harold Hein
Orient Bay
Nipigon, Ontario
P0T 2J0

Ron Morrisseau
Poplar Point First Nation
Beardmore, Ontario
P0T 1G0

Edna McLeod
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P0T 1G0

Gerald Lester
Band Manager
Rocky Bay First Nation
Rocky Bay General Delivery
MacDiarmid, Ontario
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P0T 1G0

Noella Kelly
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P0T 1G0

Edgar J. Lavoie
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Geraldton, Ontario
P0T 1M0

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Thunder Bay, Ontario
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Dave Dupuis
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P0T 1G0

Buzz Taisey
Orient Bay
Nipigon, Ontario
P0T 2J0

Chief James Hardy
Rocky Bay First Nation
Rocky Bay General Delivery
MacDiarmid, Ontario
P0T 2B0

Pat Hardy
Rocky Bay First Nation
Rocky Bay General Delivery
MacDiarmid, Ontario
P0T 2B0

Gerry and Alma Adams
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P0T 2J0

Charles Parohl
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Red Rock, Ontario
P0T 2P0

Gary Lange
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P0T 2J0

Phil Douglas
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P0T 2J0

Art Joseph
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Nipigon, Ontario
P0T 2J0

James Henriksson
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Nipigon, Ontario
P0T 2J0

Jerry Brennan
Reeve, Town of Nipigon
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Nipigon, Ontario
P0T 2J0

Lawrence & Sharryn McCollum
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Nipigon, Ontario
P0T 1G0

Art & Olga Jalkanen
Royal Windsor Lodge
R.R. 1,
P0T 1G0

Bob Matchett
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Tent and Trailer Park
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P0T 2J0

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Sandy & Doris Coveyduck
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Joe Williams/Dale Kivilahti
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Township of Red Rock
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P0T 2P0

Adam Taff
Public Works Superintendent
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Harold Blanchett
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Ken Mackie
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P7B 5E7

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Lakehead University
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Thunder Bay, Ontario
P7B 5E1

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Technical Superintendent
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Red Rock Mill
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Appendix 3C

Interview Questions for Stakeholders

Lake Levels Management Plan for the Lake Nipigon and Nipigon River System
-Interview Questions-

Introduction

The Nipigon River Watershed Management Committee has contracted a team of consultants lead by Atria Engineering Hydraulics Inc. of Mississauga to design a water levels management plan for Lake Nipigon and the Nipigon River system.

The management plan is to ensure that the Nipigon River environment, particularly the fishery, south of Ontario Hydro's Alexander Dam damaged because of fluctuating water levels, is restored and protected. The effect the management plan will have on Lake Nipigon levels also is to be considered.

Those who use the system will be consulted throughout the development of the plan.

The first step is to meet with those who use the system and talk about the relevant issues. The answers to the interview questions will help the consultants to develop appropriate management options that will be considered. Any additional information that has not been asked for, but that should be considered, would be appreciated.

Interview Questions

1. Which part(s) of the system do you use: Lake Nipigon; the Nipigon River between Pine Portage Dam and Alexander Dam; and/or the Nipigon River south of Alexander Dam.
2. Do fluctuations in the water level affect your use or enjoyment of the system and/or the potential for tourism?
3. Which effects you more: a high level or a low level?
4. When during the year do you use the system? When is your use or enjoyment most affected by any fluctuation in the level of the water?
5. What is the range in which the level can fluctuate before your use or enjoyment is affected?
6. At what point (e.g. when the water is less than a certain depth or rises to within some distance from the shoreline) does the level make it impossible for you to use of the system.
7. How, in general, does this inability to use or enjoy the system affect you and others?
8. What loss (financial or otherwise) do you experience? What loss does the community, in general, experience?
9. How often do you experience a loss resulting from fluctuating levels?
10. How significant is this loss? (For example, this loss represents X percent of my annual income or X dollars in lost income.)
11. How do you think the impact of fluctuating levels can be reduced or eliminated?

NAME ______________________________

ADDRESS ______________________________

____

PHONE(S)

FAX ______________________________

REPRESENTING: SELF ______ ORGANIZATION ______________________________

SECTOR: COMMERCIAL FISHING TOURIST RESORT/CRUISER LODGES
COTTAGER OTHER ______________________________

1. Which part(s) of the system do you use:

Lake Nipigon _____

the Nipigon River between Pine Portage Dam and Alexander Dam _____

Nipigon River south of Alexander Dam _____

2. Do fluctuations in the water level affect your use or enjoyment of the system?
YES _____ NO _____

and/or the potential for tourism

YES _____ NO _____

3. Which effects you more: high level _____ low level _____

4. When during the year do you use the system? ______________________________

When is your use or enjoyment most affected by any fluctuation in the level of the water? ______________________________

____

____

____

5. What is the range in which the level can fluctuate before your use or enjoyment is affected?

6. At what point (e.g. when the water is less than a certain depth or rises to within some distance from the shoreline) does the level make it impossible for you to use of the system.

7. How, in general, does this inability to use or enjoy the system affect you and others?

8. What loss (financial or otherwise) do you experience? What loss does the community, in general, experience?

9. How often do you experience a loss resulting from fluctuating levels?

10. How significant is this loss? (For example, this loss represents X percent of my annual income or X dollars in lost income.)

11. How do you think the impact of fluctuating levels can be reduced or eliminated?

12. Do you think the fishery should be:

managed for use primarily by locals _____
promoted as a world-class resource and a tourist attraction _____

Appendix 4A

Ontario Hydro Utilization Guideline
Lake Nipigon Utilization Plan 1991/1992

UTILIZATION GUIDELINE (UG)

FROM: OPERATIONS PLANNING DEPARTMENT

TO: SYSTEM OPERATION DEPARTMENT

TO:	Supervising Engineer - System Production Clarkson SCC Mr. C.H. Stevens	**UG NO:**	H700-R2
SUBJECT:	Lake Nipigon Utilization Plan for 1991/1992	**DATE ISSUED:**	Nov 28/91
		REVIEW DATE:	Oct 1/92
		SUPERSEDES UG NO:	H700-R1

INTRODUCTION

This UG provides a utilization plan for Lake Nipigon for the period November 1991 to September 1992.

GUIDELINES

Inflow conditions have improved and are expected to be at 75% of time exceedence until freshet begins. Inflows are expected to increase to median during freshet and stay at that level until September.

The Ogoki reservoir has been set for the winter period to provide a minimum elevation on Mojikit Lake. Summit Dam discharge is expected to average about 60 cms up to the start of freshet.

Pine Portage discharge is a constant 245 cms throughout the winter and should bring the level of Lake Nipigon to 259.4 prior to freshet. The remaining storage (ie, 259.3 m - 259.4 m) can be used if necessary to help with power system contingencies etc.

The hourly discharge from Alexander GS is not to be reduced below 245 cms to ensure the fall brook trout spawn remains immersed. The landslide downstream of Alexander GS in April 1990 wiped out the fish spawn of the previous fall. The Ministry of Natural Resources has asked for Ontario Hydro's cooperation to help provide good conditions over the next spawning season.

A peaking restriction is in place downstream of Alexander GS. There is no restriction on increases but the flow reduction is limited as follows.

* The maximum flow reduction over a 24 hour period is 100 cms.
* The flow reduction must be done in stages. The maximum reduction in a single event is 50 cms.
* A minimum of 4 hours must pass between flow reductions.
* The 24 hour period begins with the first flow reduction.

The utilization plans described in this UG may be revised as conditions change. For the current plans, contact Mr. R.P. Vinski at Local 2031.

Approved by:

Section Head -
River & Reservoir Utilization

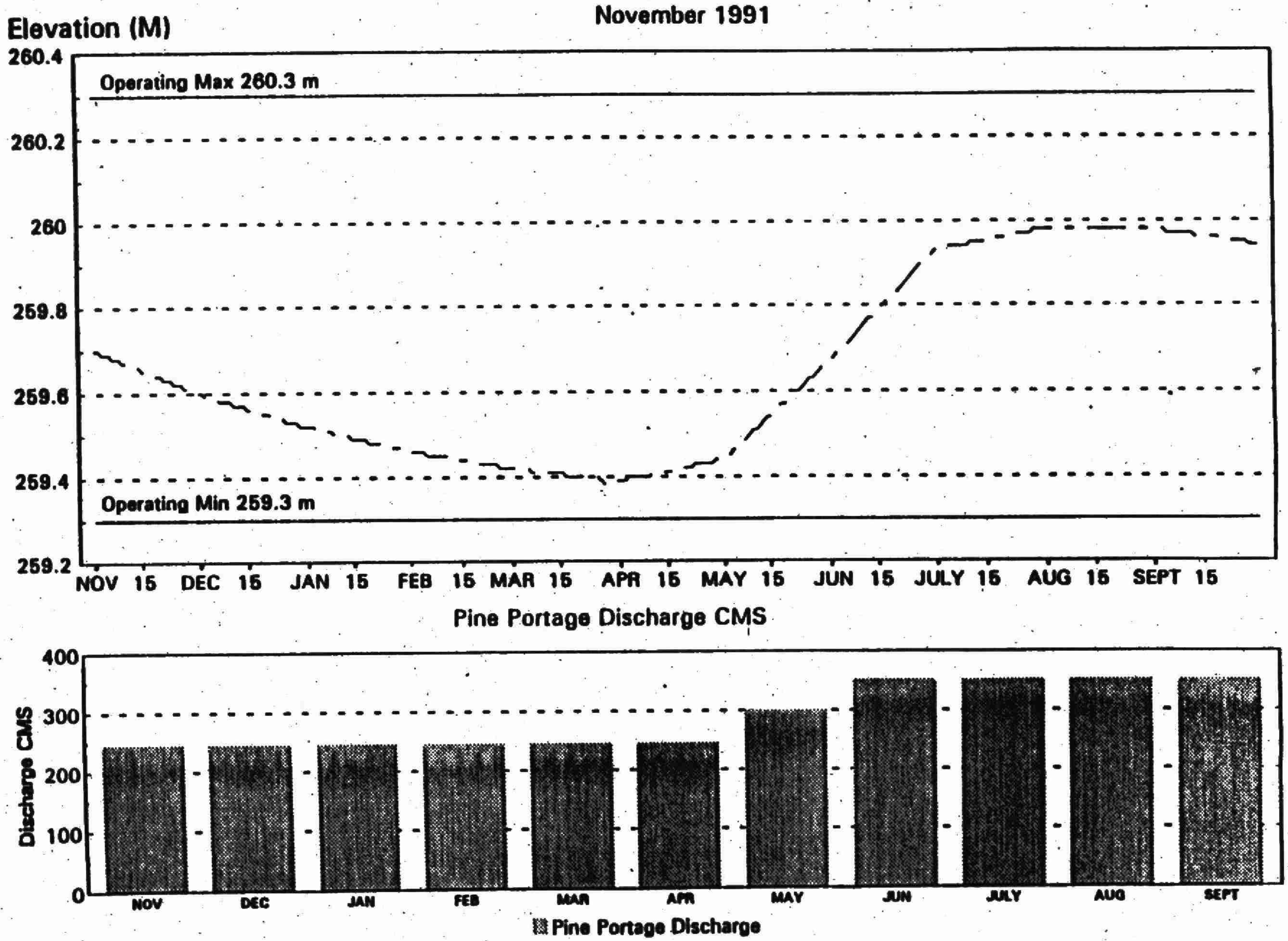
RPV:jc

Enc

5529R33

LAKE NIPIGON DRAWDOWN - UG H700 R2

November 1991



Appendix 4A.1

Computed Natural Levels and Discharges of Lake Nipigon, 1909 - 1989

LAKE NIPIGON
COMPUTED NATURAL LEVELS

The information which follows presents a summary of the INPUT DATA and METHODOLOGY used to compute the natural elevation of Lake Nipigon. The computations were originally performed in 1945 (reference CE&A Department Library Report 143-5) and updated in 1974, 1976, 1979, 1982, 1986 and 1990 (reference CE&A Department file 143-X).

INPUT DATA or INFORMATION

A) Lake Nipigon Storage

Based on Lake Nipigon Storage Table
Dated April 16, 1945

The surface area of Lake Nipigon was computed as 1,113,600 acres. This area was assumed to remain constant for any elevation of Lake Nipigon.

$$S = 1113600 * (H - 846) * 43560 \qquad 1)$$

where : S = storage volume (cubic feet)
H = Lake Nipigon elevation (feet CGD)

B) Lake Nipigon Discharge Under Natural Conditions

Based on Lake Nipigon Outflow Discharge Curve - Natural Conditions 143-A-260
Dated December 21, 1945 (attached)

This curve was originally derived in 1945 and is based on available data of mean monthly discharges observed at Cameron Falls during the years 1921-1924 and corrected for the drainage area difference between Cameron Falls and Virgin Falls.

$$QN = C_1 + C_2*(H-800) + (C_3*(H-800)^2) + (C_4*(H-800)^3) \qquad 2)$$

where : QN = natural outflow (cfs)
C_1 = 3.456484 E^{05}
C_2 = -1.911370 E^{04}
C_3 = 3.206183 E^{02}
C_4 = -1.469170
H = Lake Nipigon elevation (feet CGD)

C) <u>Lake Nipigon Storage and Outflow Relationship</u>

Using the Lake Nipigon storage relationship (equation 1) and Lake Nipigon Outflow Discharge Curve - Natural Conditions (equation 2) a relationship was derived between storage and outflow in the following form :

$$S/t = C_1 + C_2 * (X) + (C_3 * (X)^2) + (C_4 * (X)^3) \qquad 3)$$

where :

$X = QN/2 + S/t$

$C_1 = -8.882978113\ E^{02}$

$C_2 = 9.718540000\ E^{-01}$

$C_3 = -1.480000000\ E^{-07}$

$C_4 = 9.055173000\ E^{-14}$

where :

t = routing interval (month) in seconds

= (365.25/12) * 24 * 60 * 60

= 2629800 seconds

D) <u>"Net Natural Supply"</u>

The "net natural supply" component of the inflow to Lake Nipigon for the period October 1921 to November 1985 was determined using the continuity equation.

Inflow = Outflow + Change in Storage/Unit Time

$$I_o + NNS = Q + (S_2/t - S_1/t)$$

where :

I_o = Monthly mean inflow from Ogoki Diversion (cfs)

NNS = Monthly mean Net Natural Supply (cfs)

S_1 = Start of the month storage volume (cf)

S_2 = End of the month storage volume (cf)

t = routing interval (2629800 seconds)

Q = Monthly mean outflow from Lake Nipigon (cfs)

pre Jun 1950 Although the origin is at present unknown, it appears the data came from records for Nipigon River near Cameron Falls and below Virgin Falls.

Jun 1950 to Dec 1989 Pine Portage GS total flow

S_1 is determined from equation 1) using the 5 day mean start of the month elevation (average of the last 3 days of previous month and first 2 days of current month)

S_2 is determined from equation 1) using the 5 day mean end of the month elevation (average of the last 3 days of current month and first 2 days of next month)

The source of the elevation data used for the period June 1921 and February 1932 (both Orient Bay and Macdiarmid in service) is at present unknown.

The equation is re-arranged to solve for the unknown, "Net Natural Supply" (NNS)

$$NNS = Q - I_o + (S_2/t - S_1/t)$$

METHODOLOGY

The method uses a standard routing procedure employing the continuity equation. The method works quite well as long as the routing period is such that the inflow hydrograph remains reasonably flat during the routing period and is greater than the travel time. The routing period used in these studies is one month.

A month by month sequential computation is used to compute the natural elevations of Lake Nipigon.

The continuity equation is used to route historic net natural supplies.

Inflow = Outflow + Change in Storage/Unit Time

Outflow is assumed to be equal to the average of the beginning and end of the month outflows. The inflow is equal to the "net natural supply".

therefore :

$$NNS = \frac{(QN_1 + QN_2)}{2} + (S_2/t - S_1/t) \qquad 3)$$

where :

- NNS = Monthly mean Net Natural Supply (cfs)
- QN_1 = Start of the month natural outflow (cfs). Computed using the first of the month elevation.
- S_1 = Start of the month storage (cf). Computed using the 1st of the month elevation and equation 1).
- QN_2 = End of the month natural outflow (cfs)
- S_2 = End of the storage (cf)
- t = Routing interval (2629800 seconds)

To determine the end of month elevation, equation 3) is re-arranged with known quantities on the right hand side thereby solving for ($QN_2/2 + S_2/t$) as follows :

$$QN_2/2 + S_2/t = NNS + S_1/t - QN_1/2 \qquad 4)$$

The computations began on June 1, 1925. The starting elevation of Lake Nipigon on June 1, 1925 was chosen from the elevation computed in the 1946 study. In the 1946 study the June 1, 1925 elevation was the result of a series of monthly computations which began with a January 1909 starting elevation of 848.17 feet. Elevation 848.17 was chosen since it was the lowest recorded elevation for the month of January between 1921 to 1945.

1) Knowing the first of the month storage and natural discharge and net natural supply, equation 3) can be used to solve for the end of the month storage S_2.

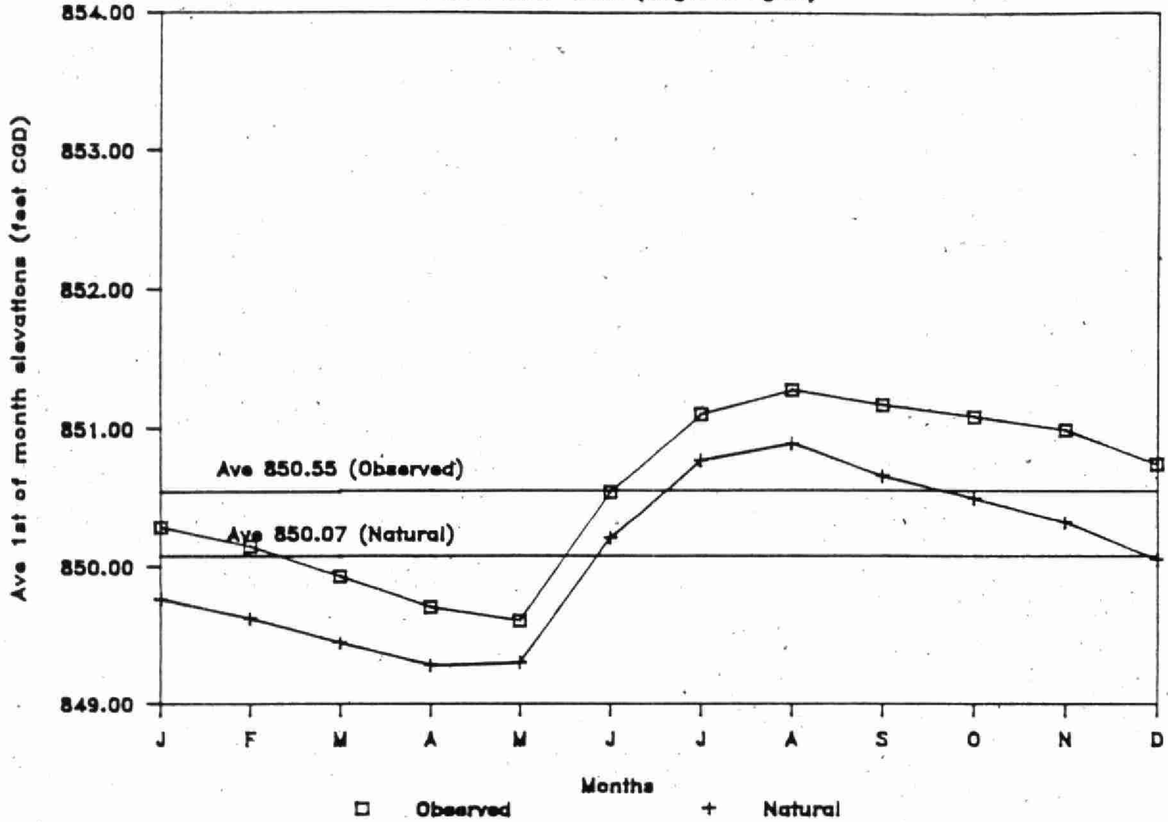
2) Re-arranging the Lake Nipigon storage relationship from equation 1) the end of the month elevation (H_2) is computed by substituting for S_2 from step 1).

3) Substituting the resultant H_2 into equation 2) the end of the month outflow (QN_2) is also determined.

The computations continue throughout each month by substituting Q_2 for Q_1 and S_2 for S_1. This process is repeated until the end of the data set is reached.

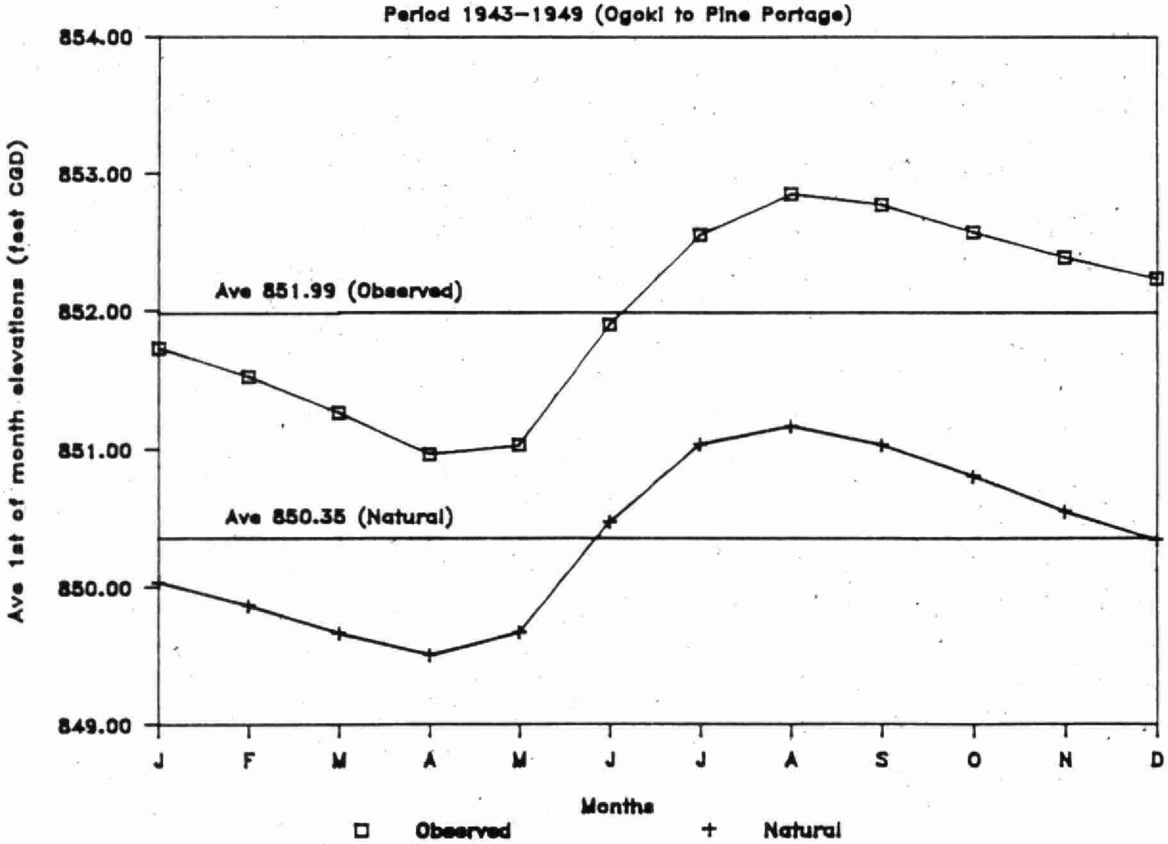
LAKE NIPIGON ELEVATIONS

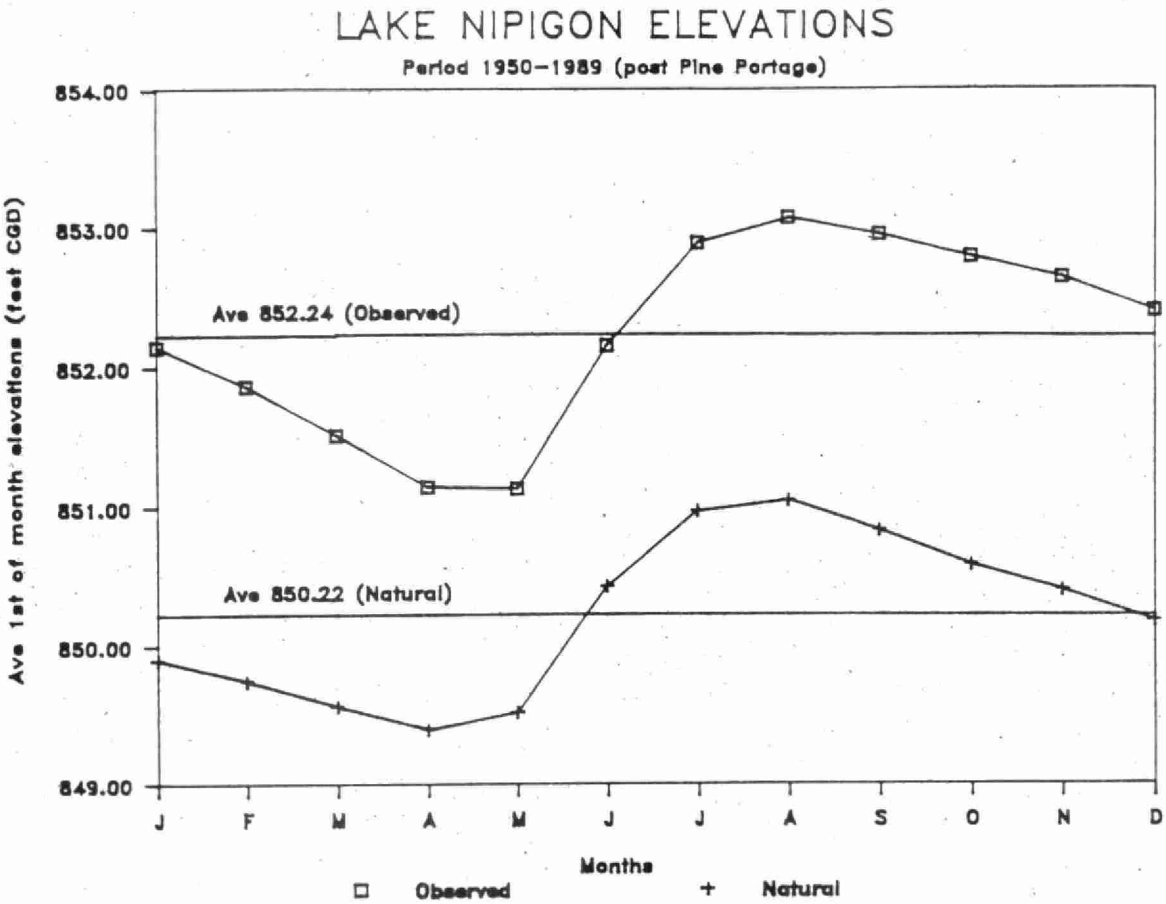
Period 1925–1943 (Virgin to Ogoki)

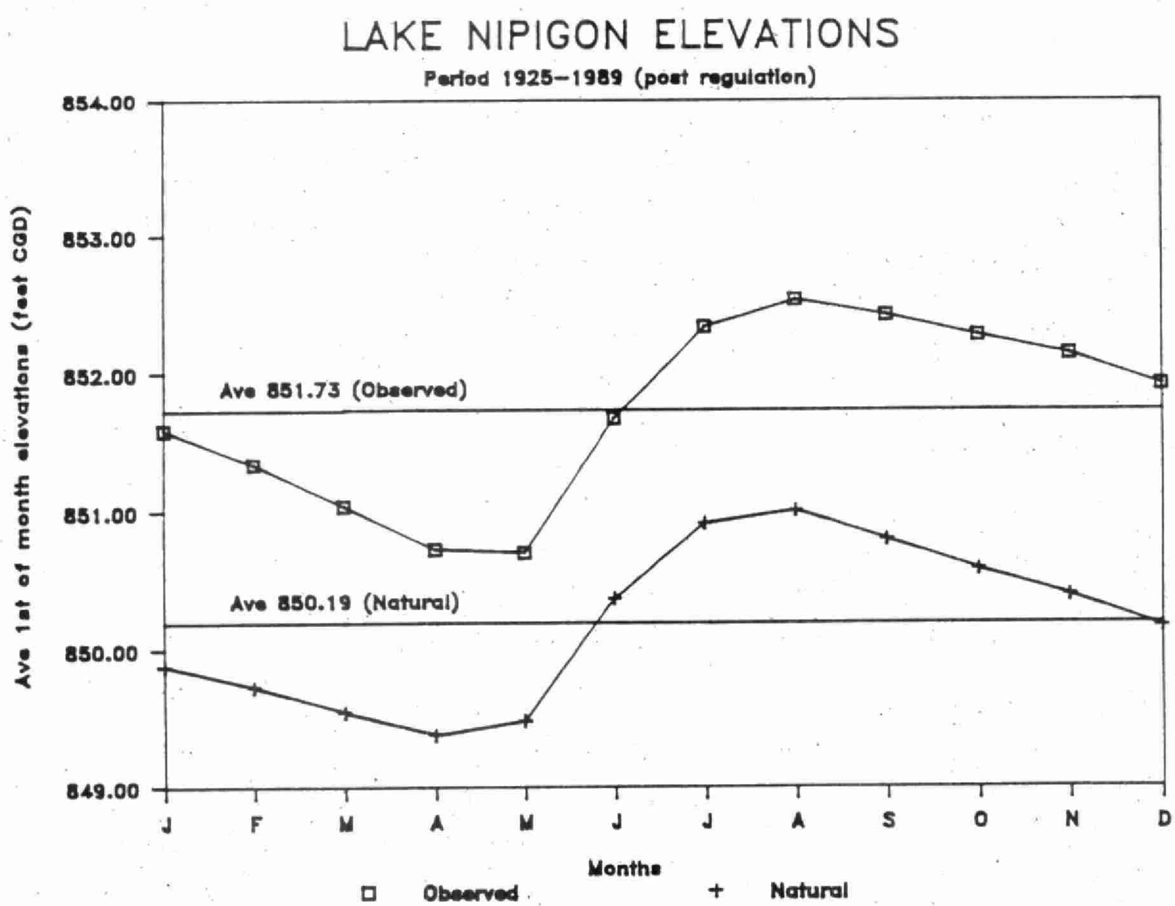


LAKE NIPIGON ELEVATIONS

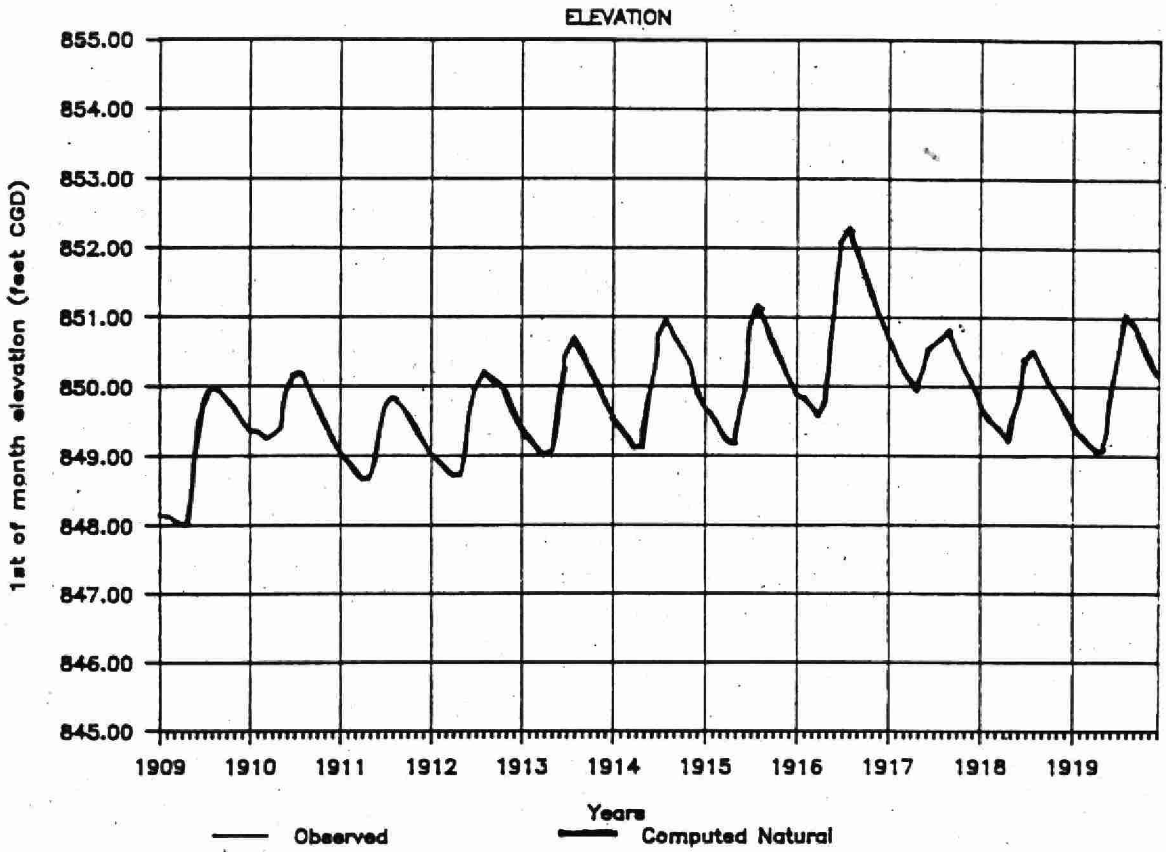
Period 1943–1949 (Ogoki to Pine Portage)

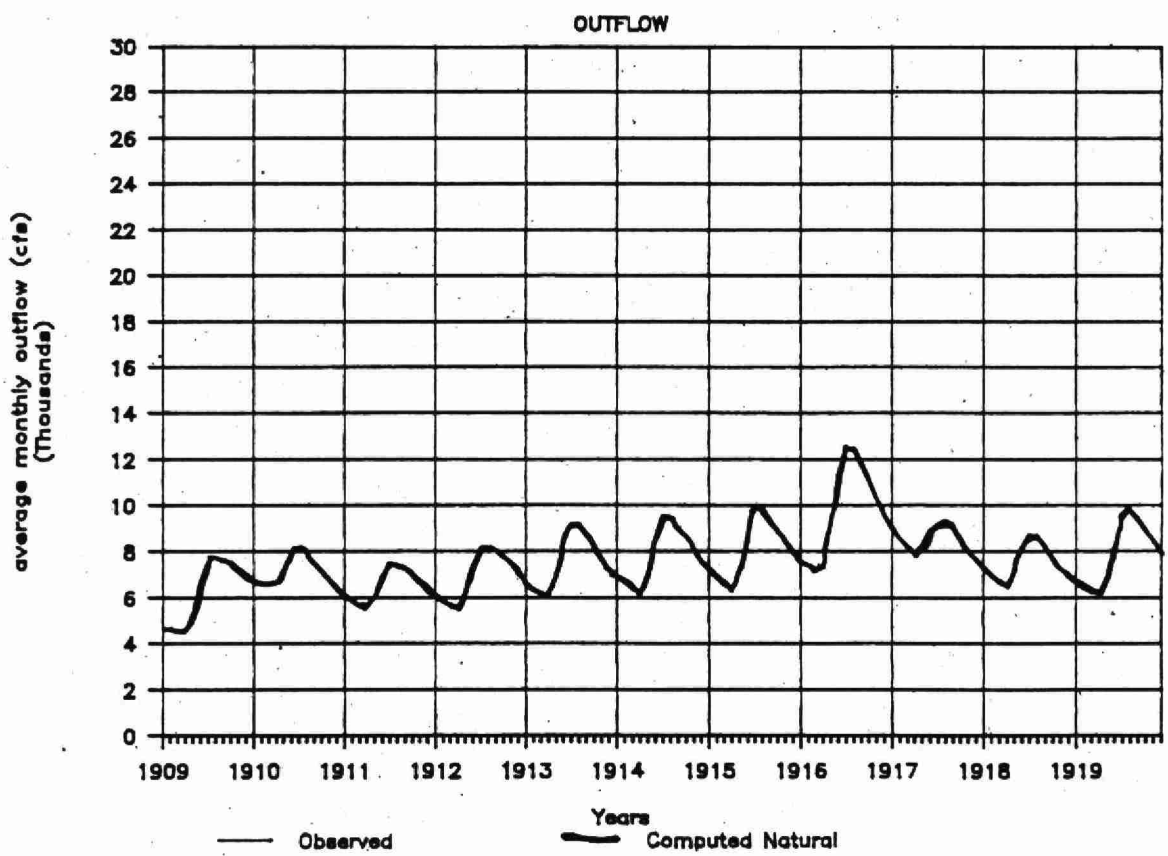



LAKE NIPIGON ELEVATIONS
Period 1950–1989 (post Pine Portage)
854.00
853.00
852.00
851.00
850.00
849.00
Ave 1st of month elevations (feet CGD)
Ave 852.24 (Observed)
Ave 850.22 (Natural)
J F M A M J J A S O N D
Months
Observed
Natural


LAKE NIPIGON ELEVATIONS
Period 1925–1989 (post regulation)
854.00
853.00
852.00
851.00
850.00
849.00
Ave 1st of month elevations (feet CGD)
Ave 851.73 (Observed)
Ave 850.19 (Natural)
J F M A M J J A S O N D
Months
Observed
Natural

LAKE NIPIGON





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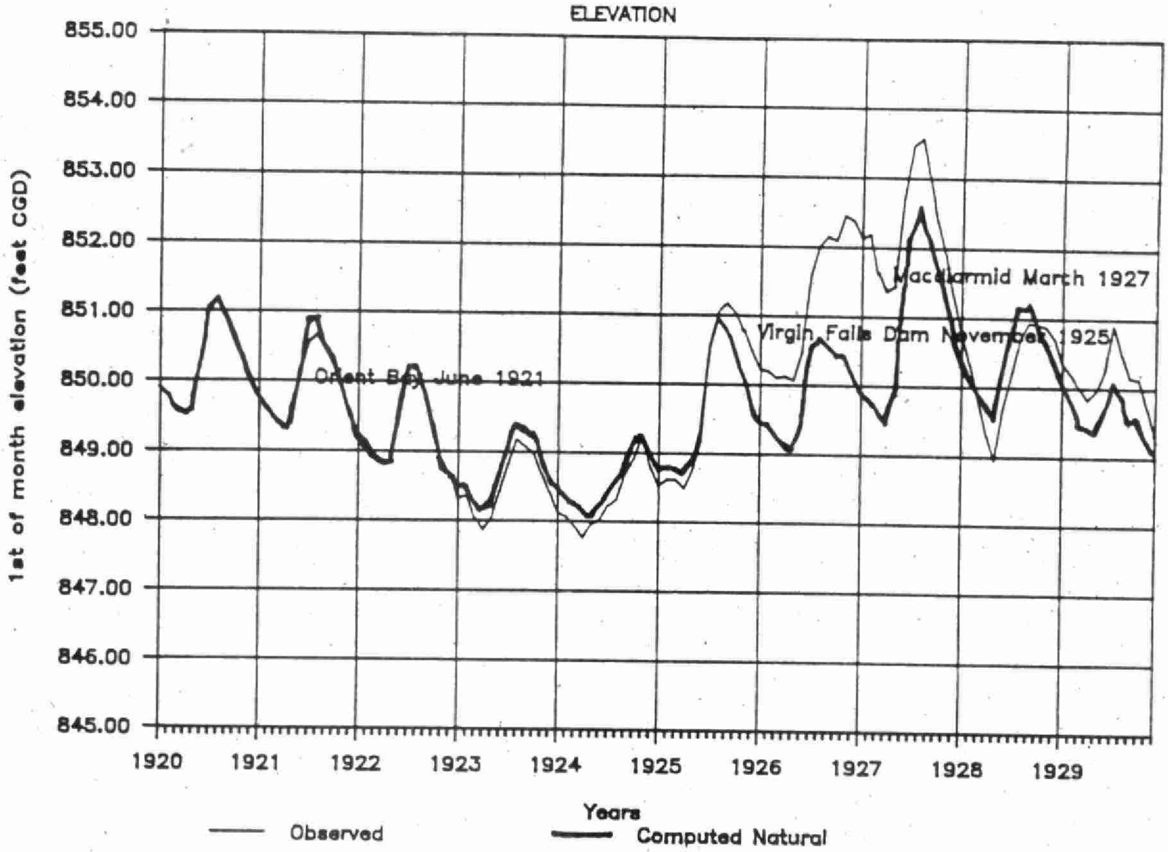

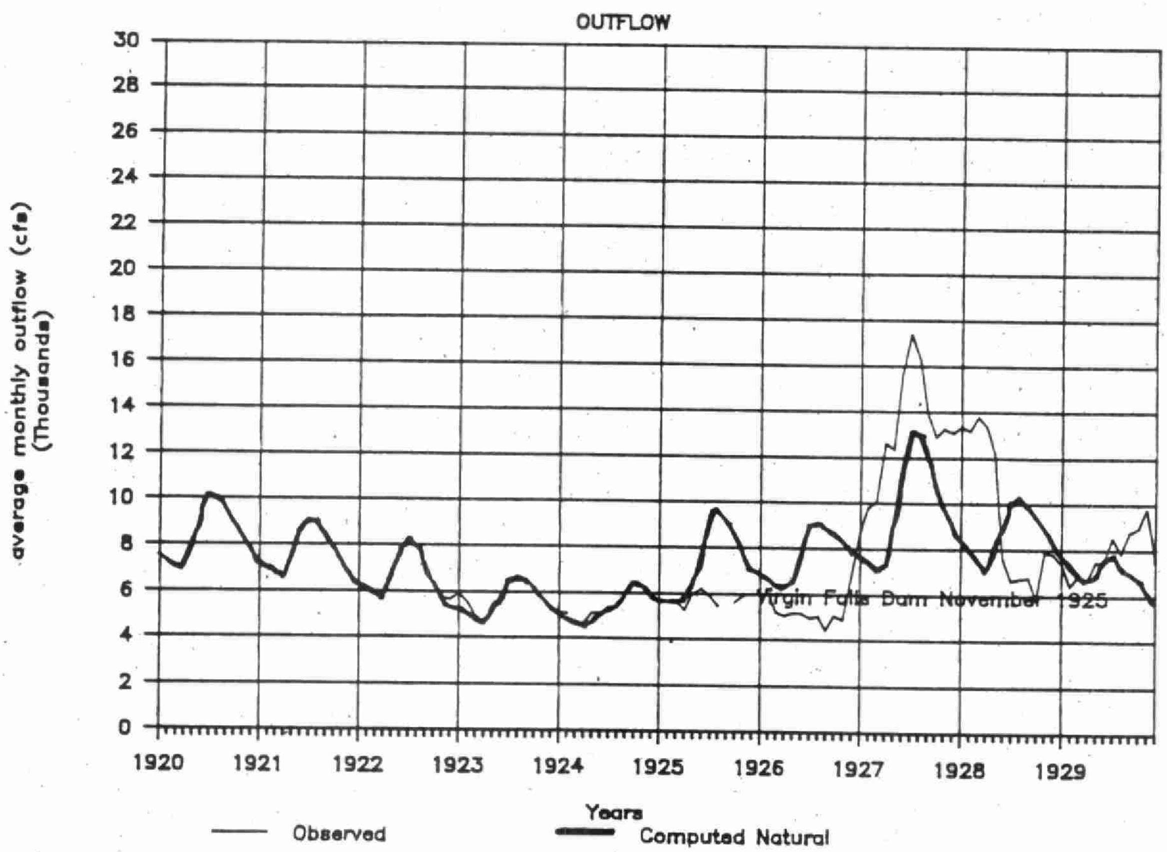

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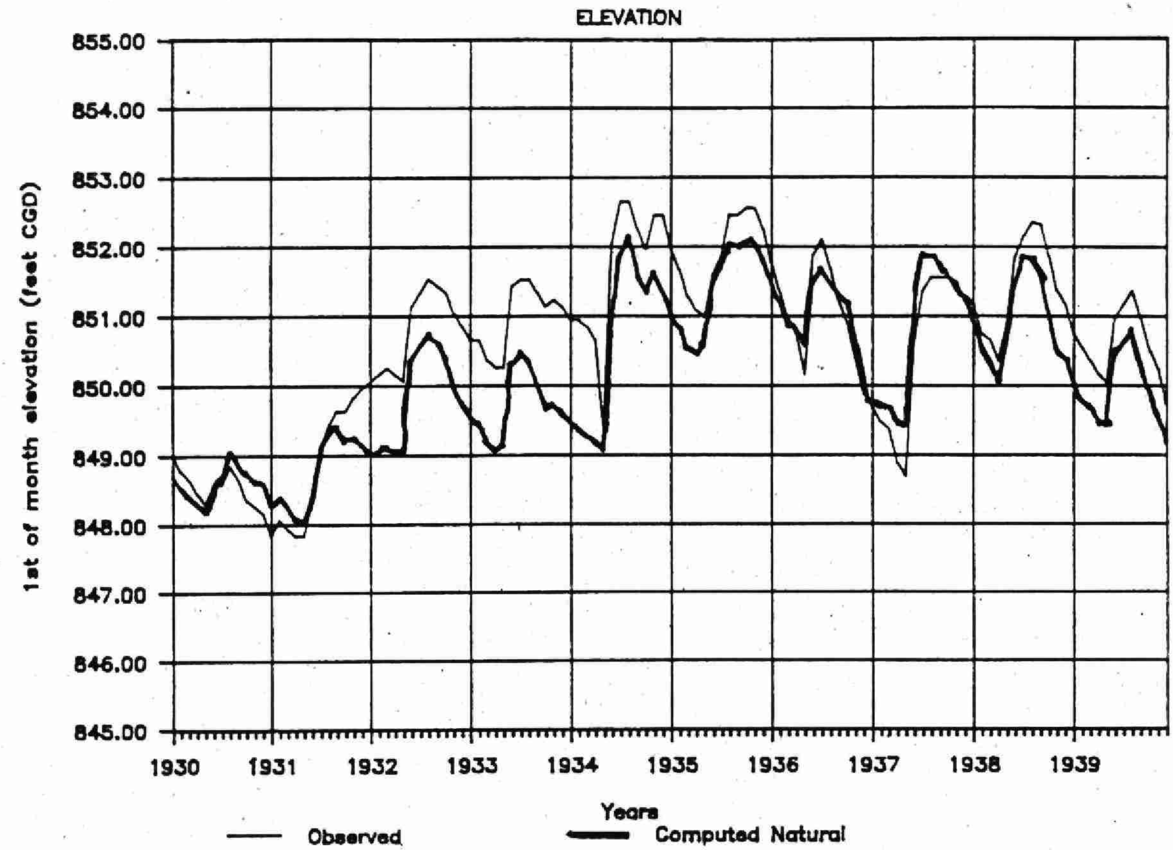
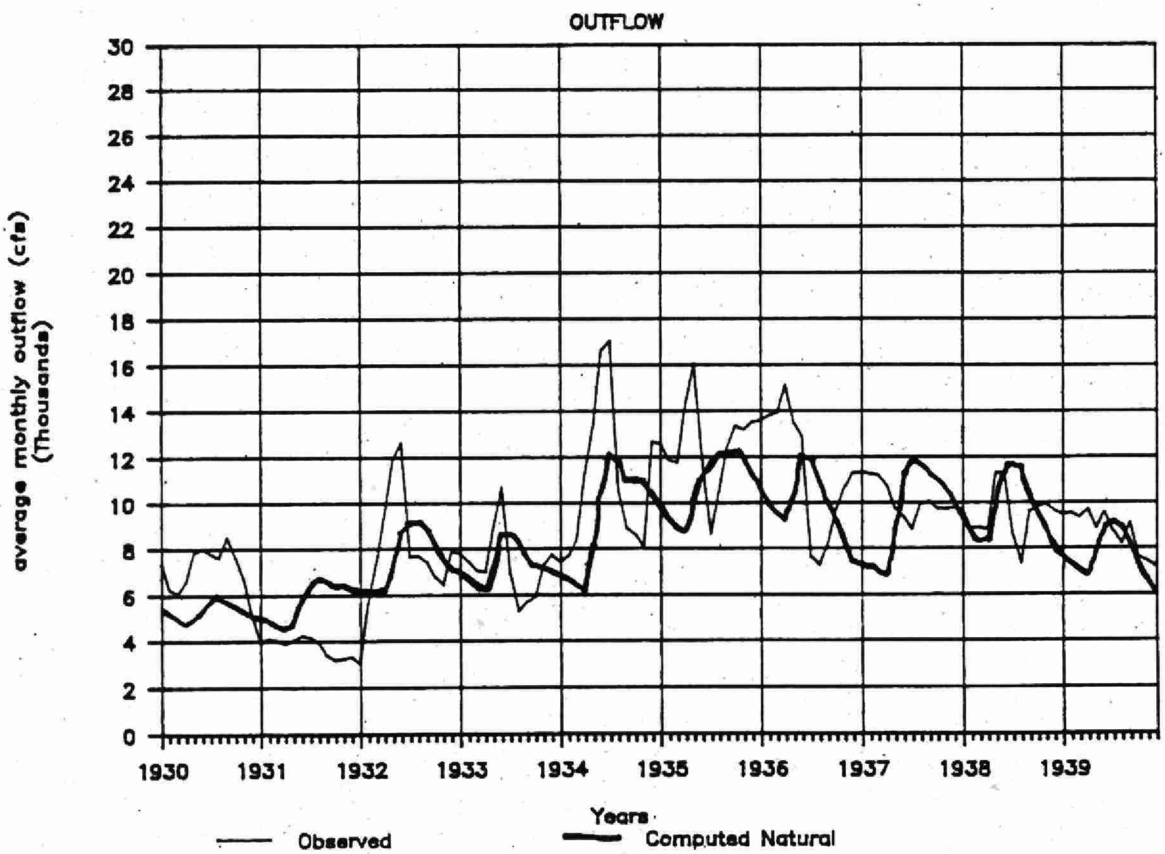
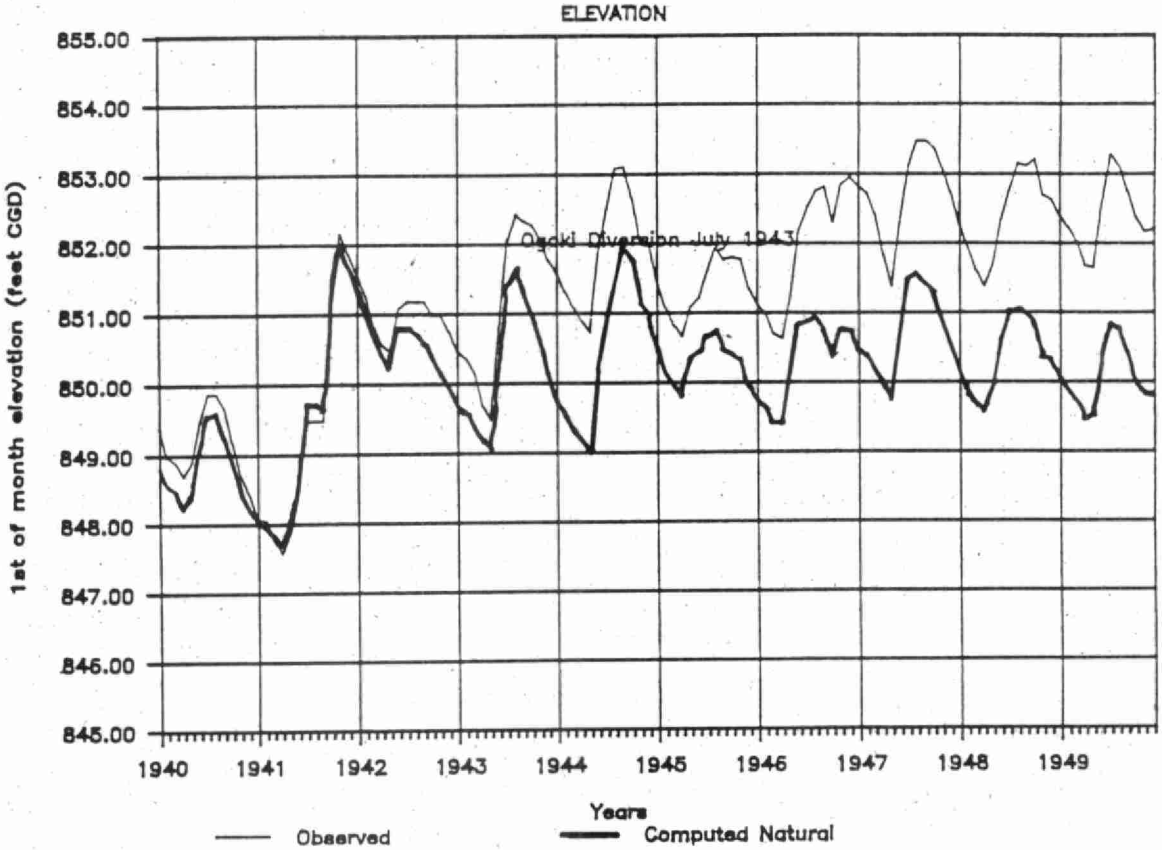
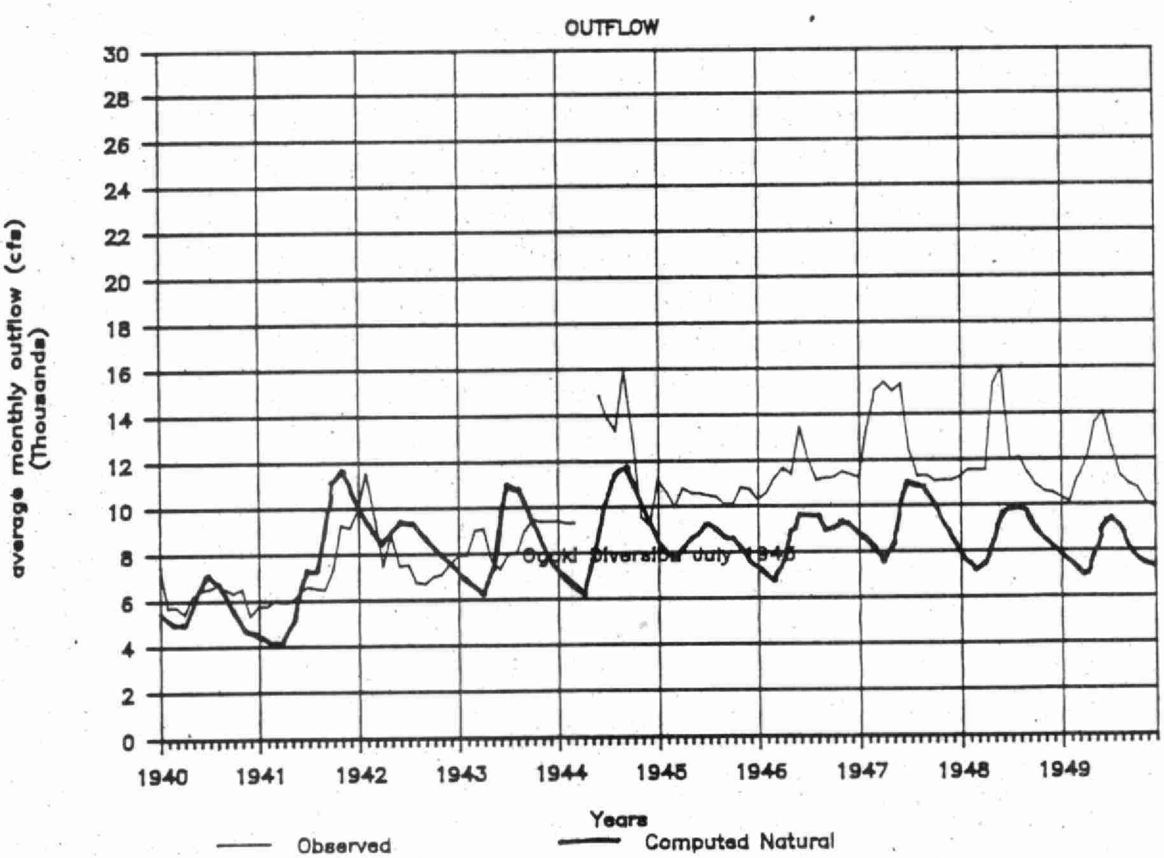




LAKE NIPIGON





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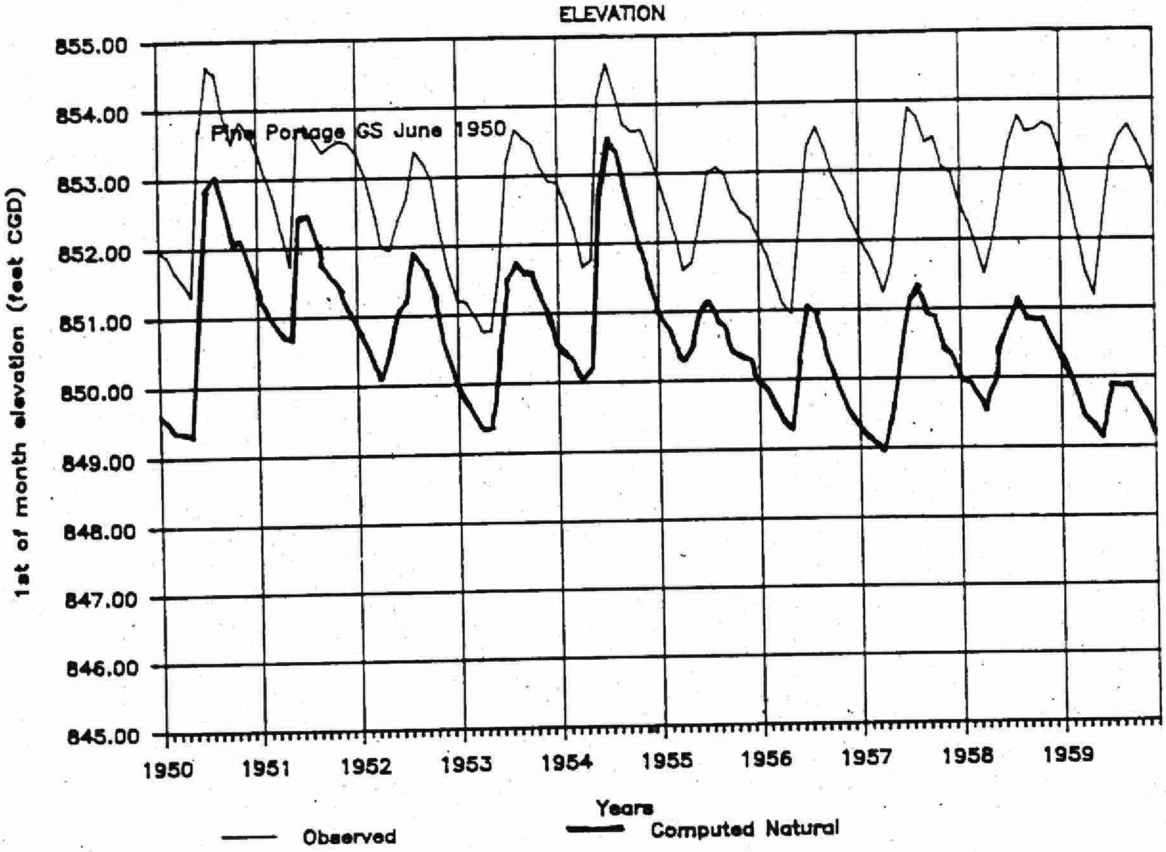
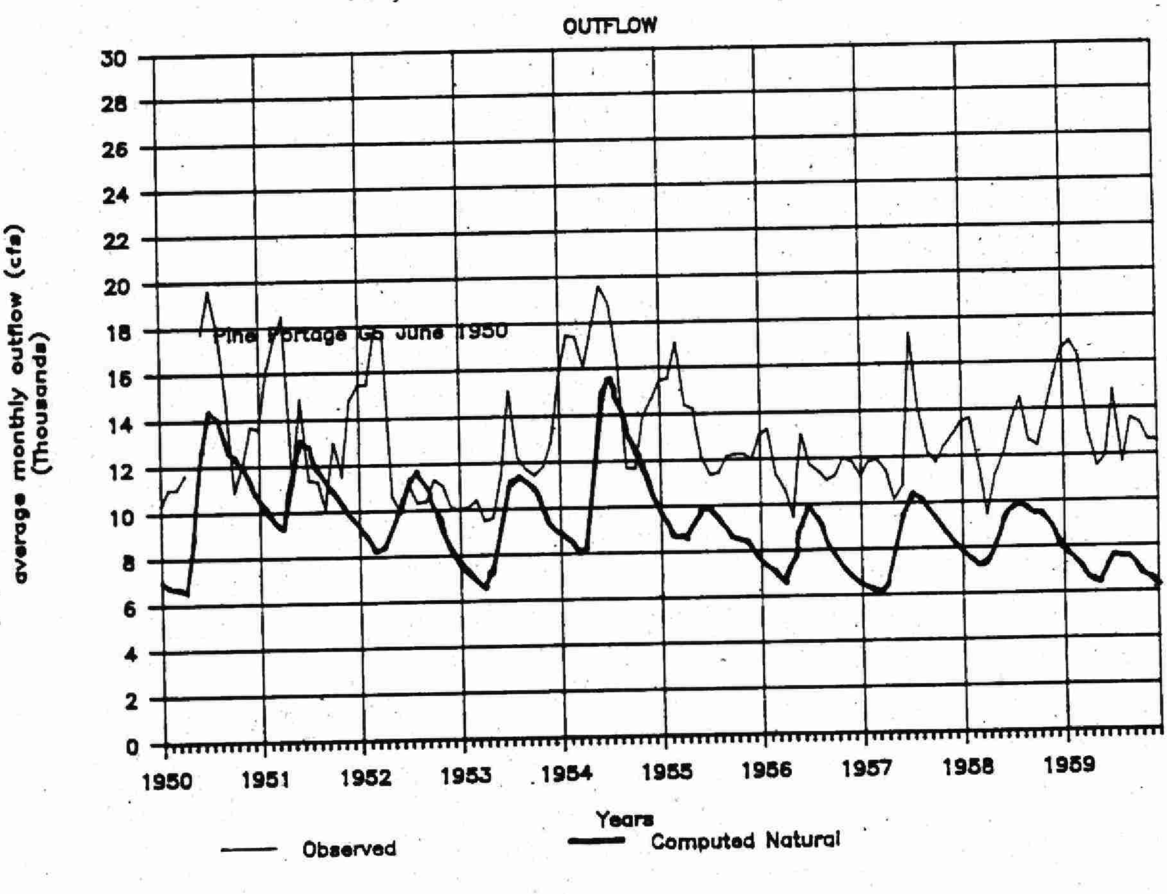
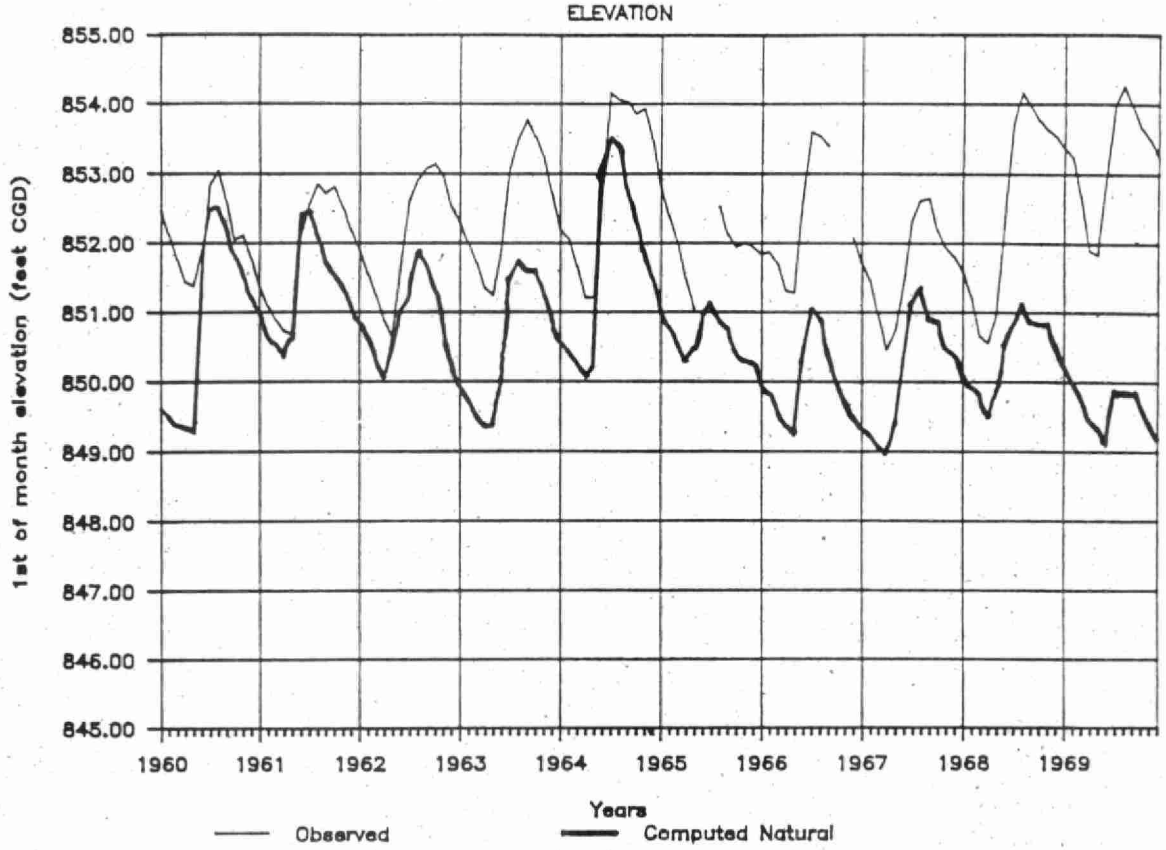
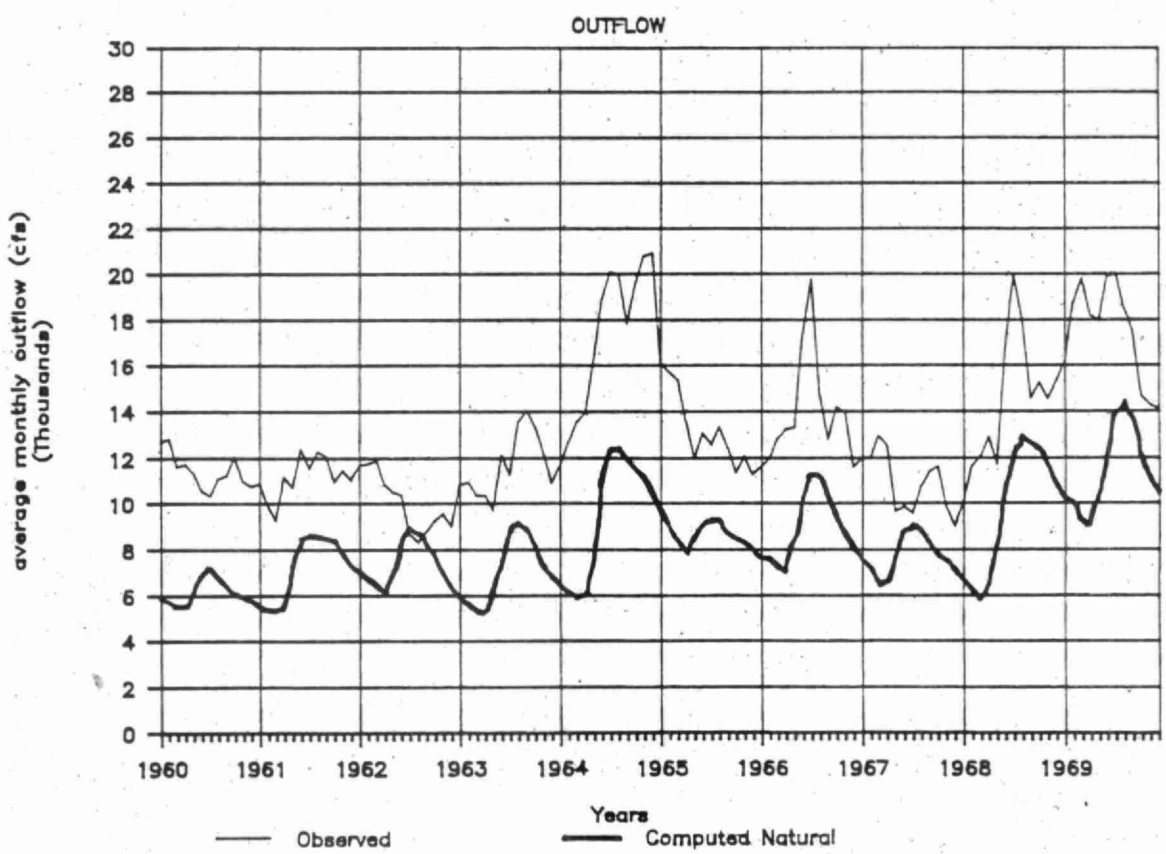


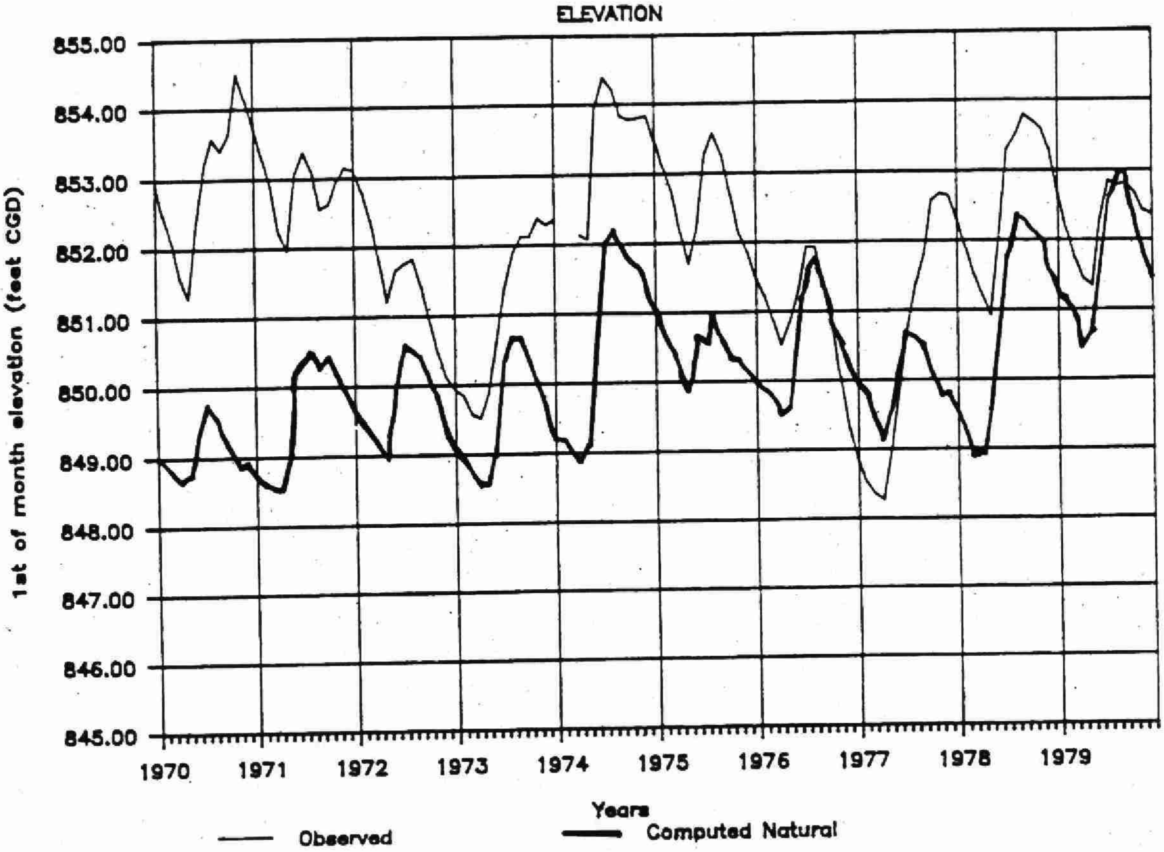


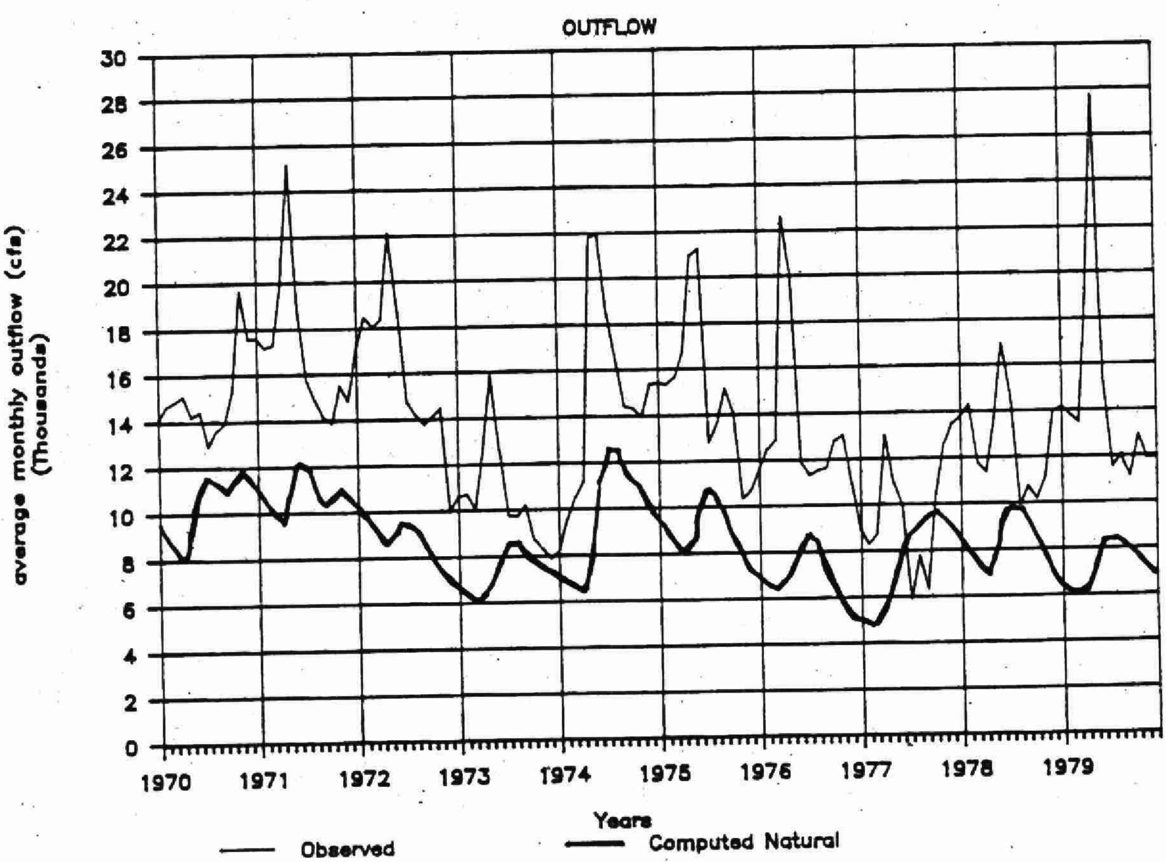
LAKE NIPIGON



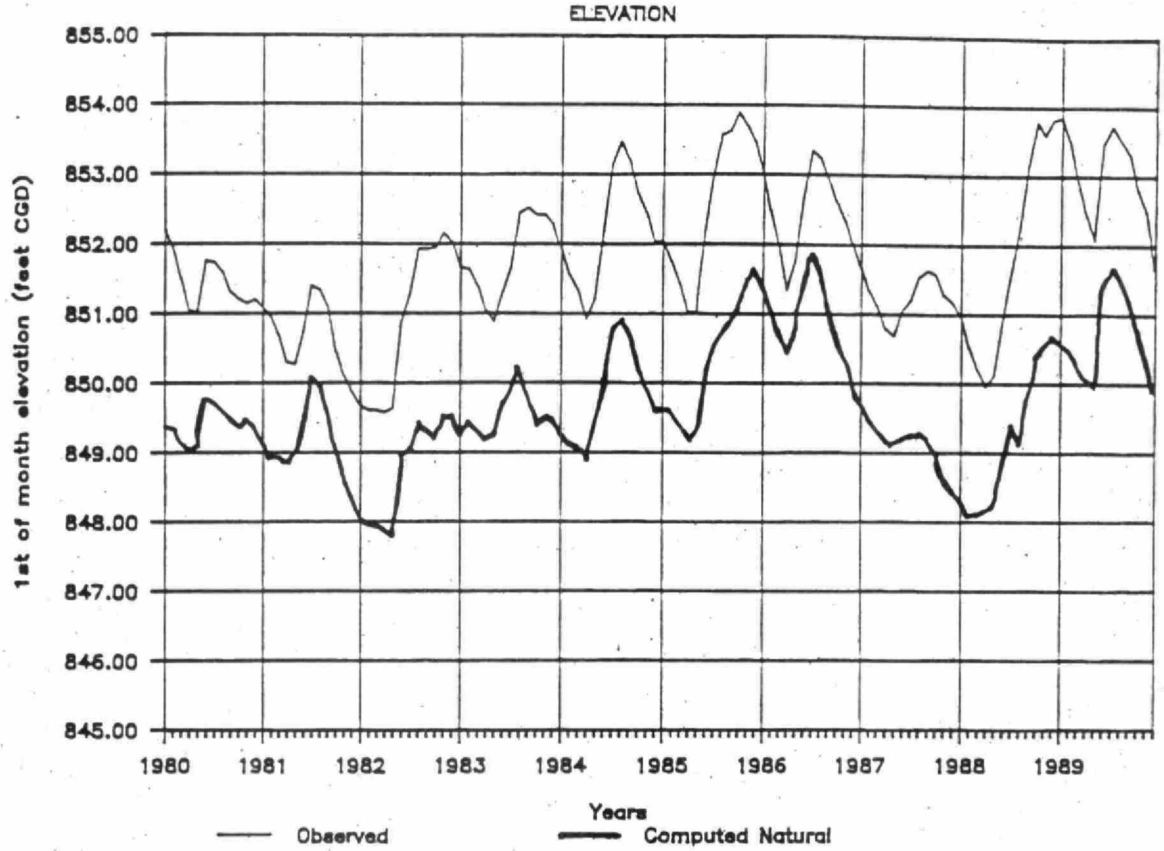


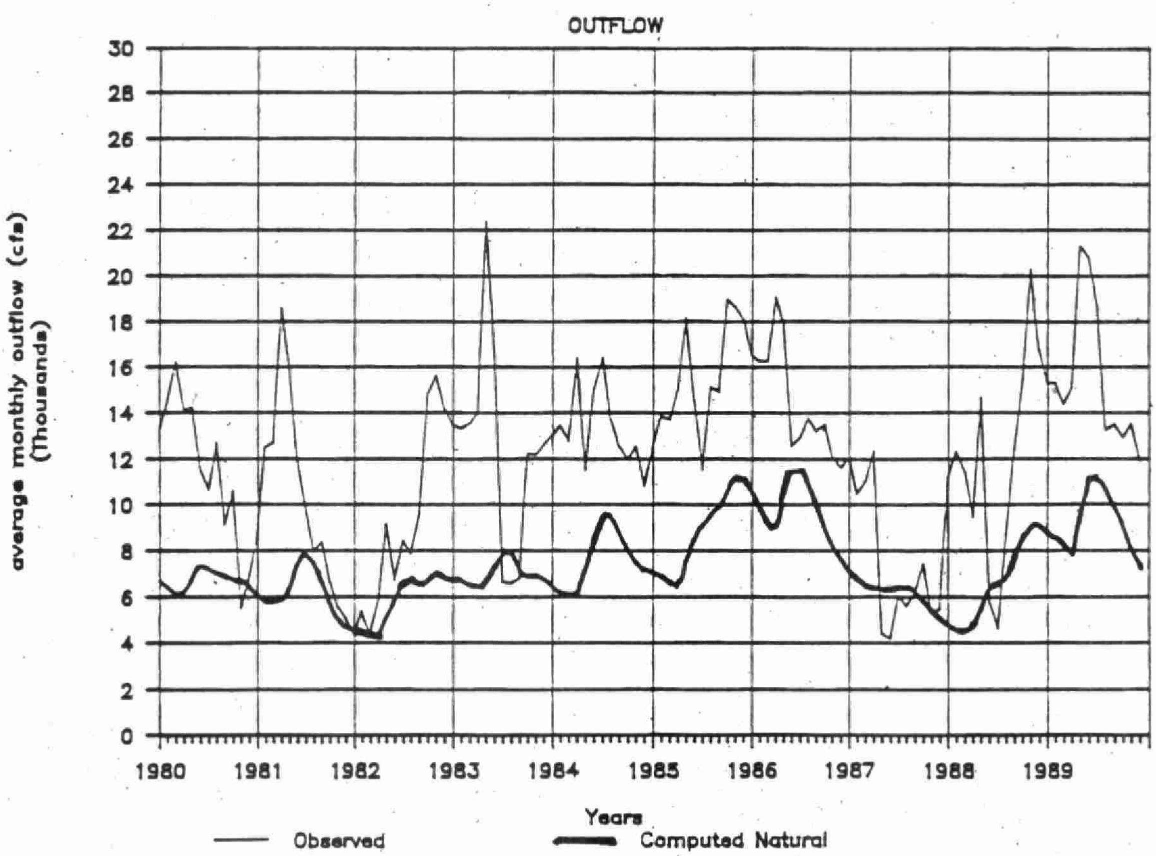
LAKE NIPIGON





LAKE NIPIGON





Appendix 4B

Minimum Daily Flow Rates from Hourly Records at Alexander GS, 1980 - 1992

Figure 1: Nipigon River Minimum Daily Flow Rate at Alexander Falls Generating Station Taken from Hourly Measurements: January 1986 through May 1986

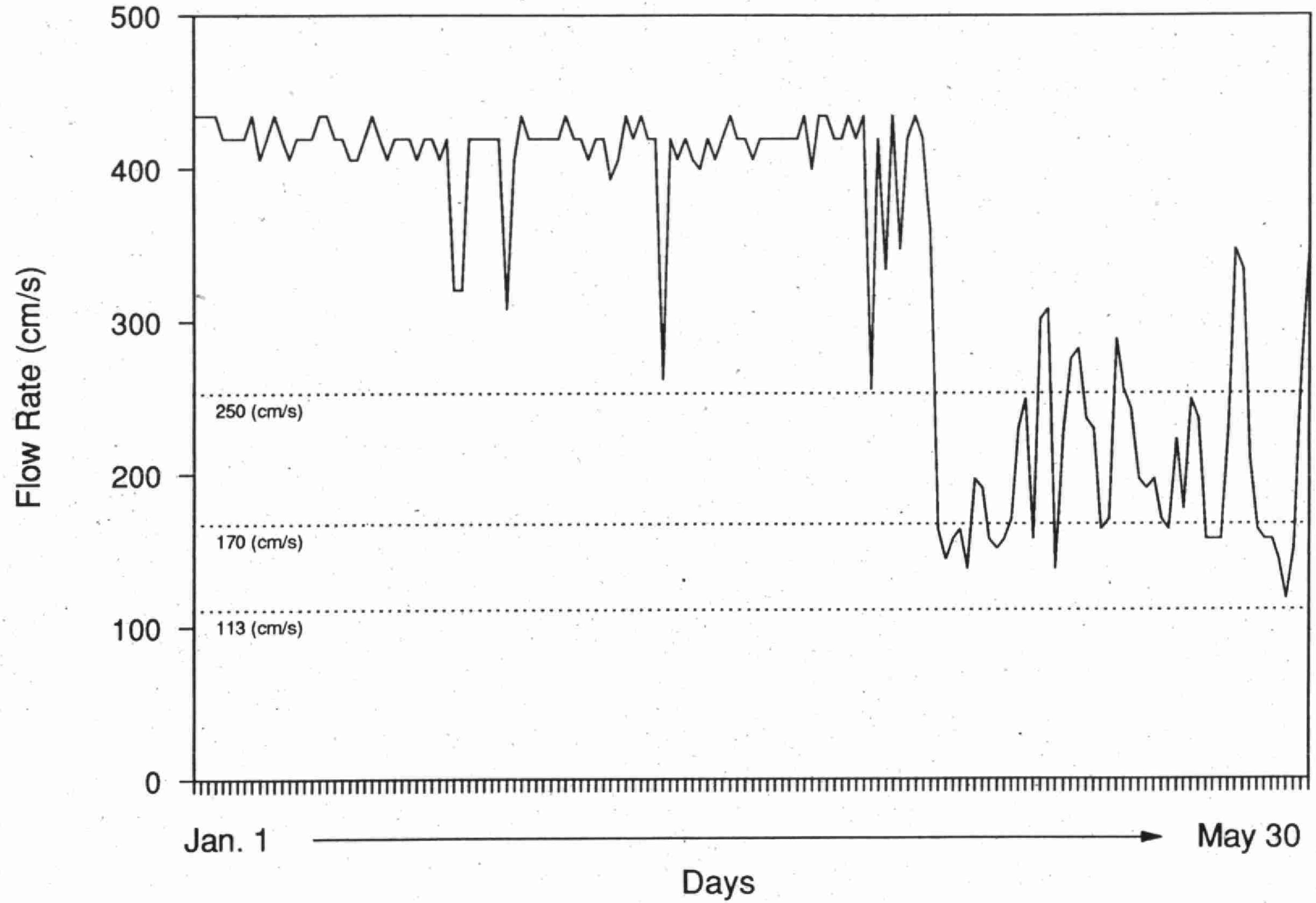


Figure 2: Nipigon River Minimum Daily Flow Rate at Alexander Falls Generating Station Taken from Hourly Measurements: October 1986 through May 1987

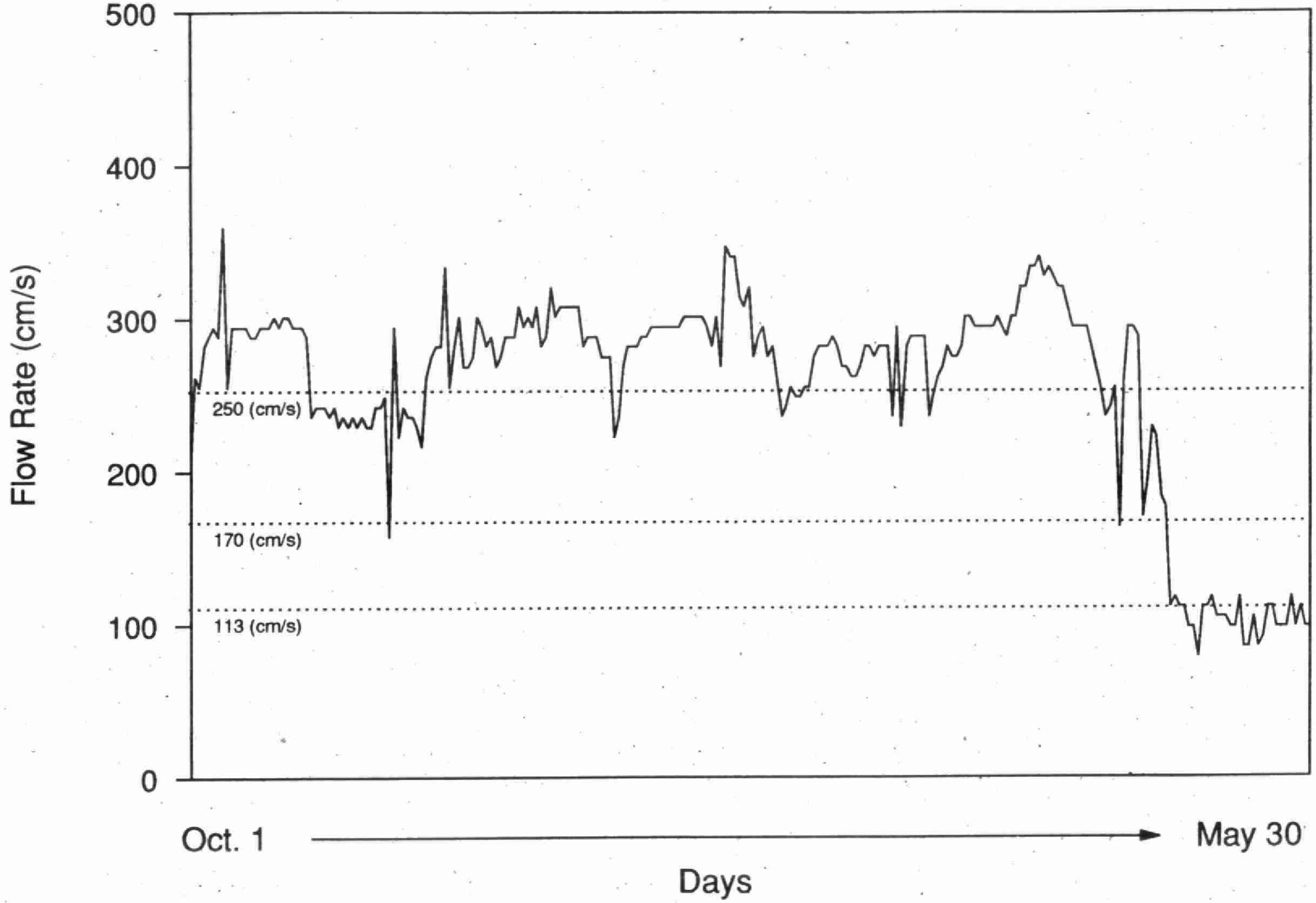


Figure 3: Nipigon River Minimum Daily Flow Rate at Alexander Falls Generating Station Taken from Hourly Measurements: October 1987 through May 1988

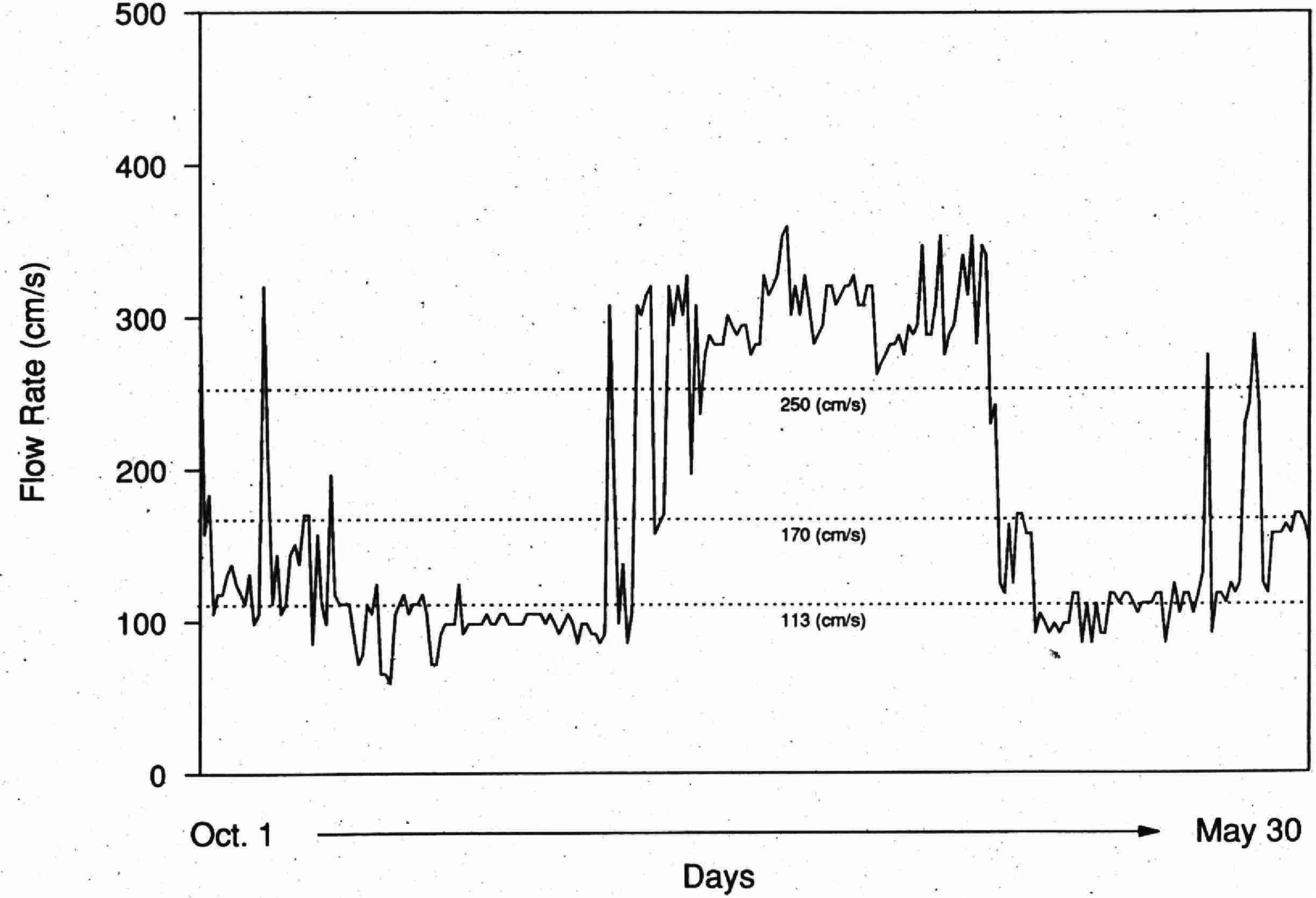


Figure 4: Nipigon River Minimum Daily Flow Rate at Alexander Falls Generating Station
Taken from Hourly Measurements: October 1988 through May 1989

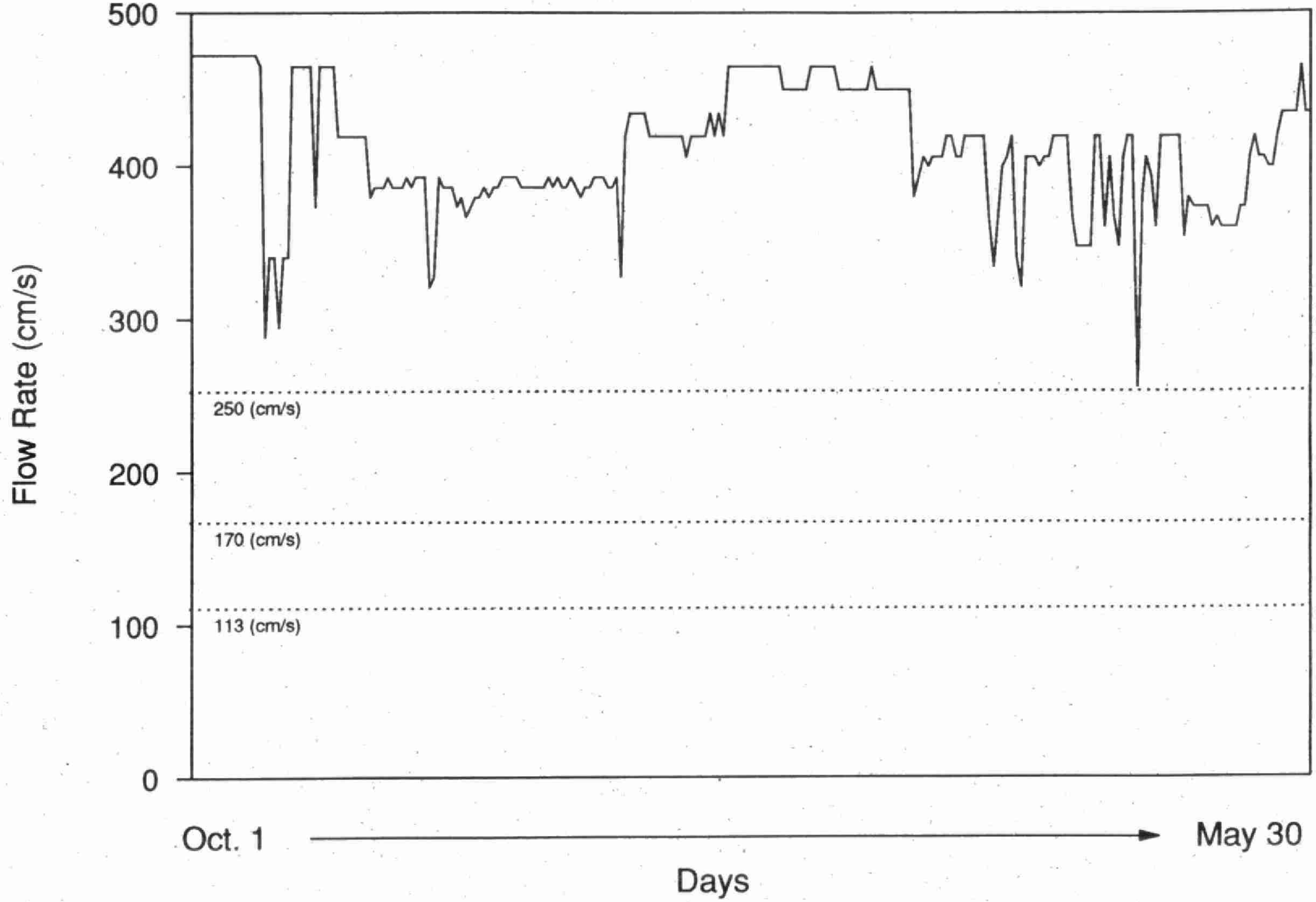


Figure 5: Nipigon River Minimum Daily Flow Rate at Alexander Falls Generating Station Taken from Hourly Measurements: October 1989 through May 1990

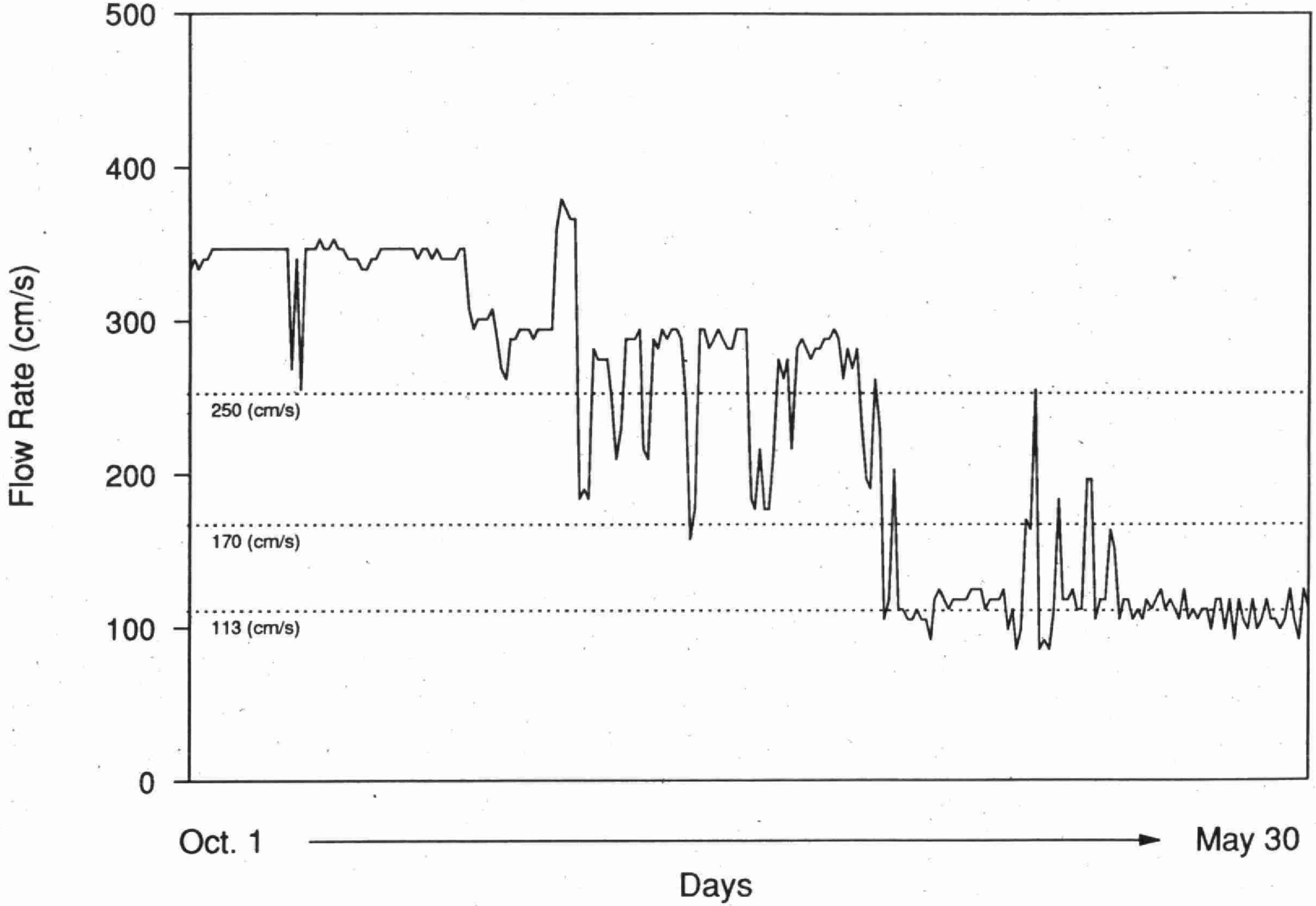


Figure 6: Nipigon River Minimum Daily Flow Rate at Alexander Falls Generating Station Taken from Hourly Measurements: October 1990 through May 1991

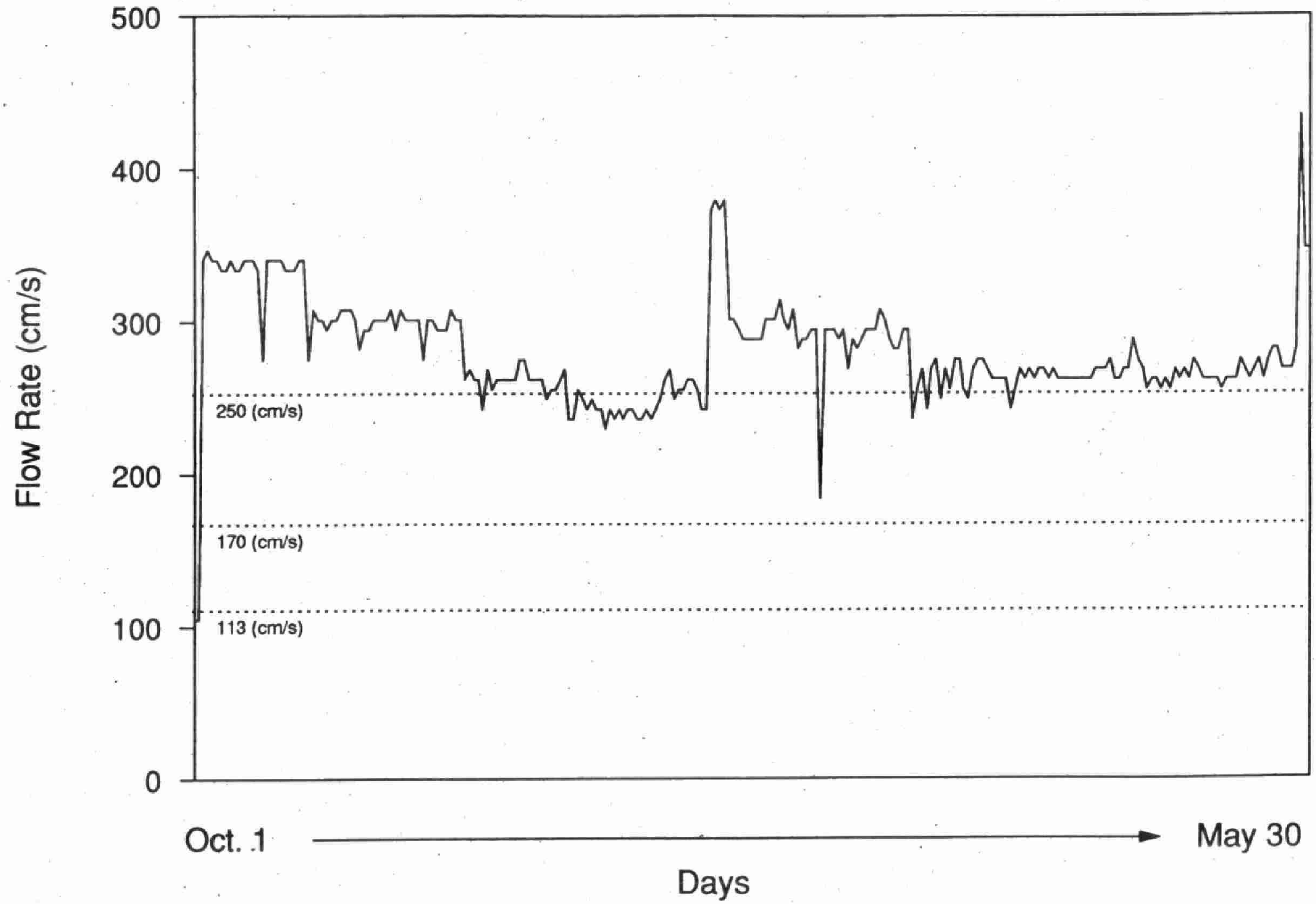


Figure 7: Nipigon River Minimum Daily Flow Rate at Alexander Falls Generating Station Taken from Hourly Measurements: October 1991 through May 1992

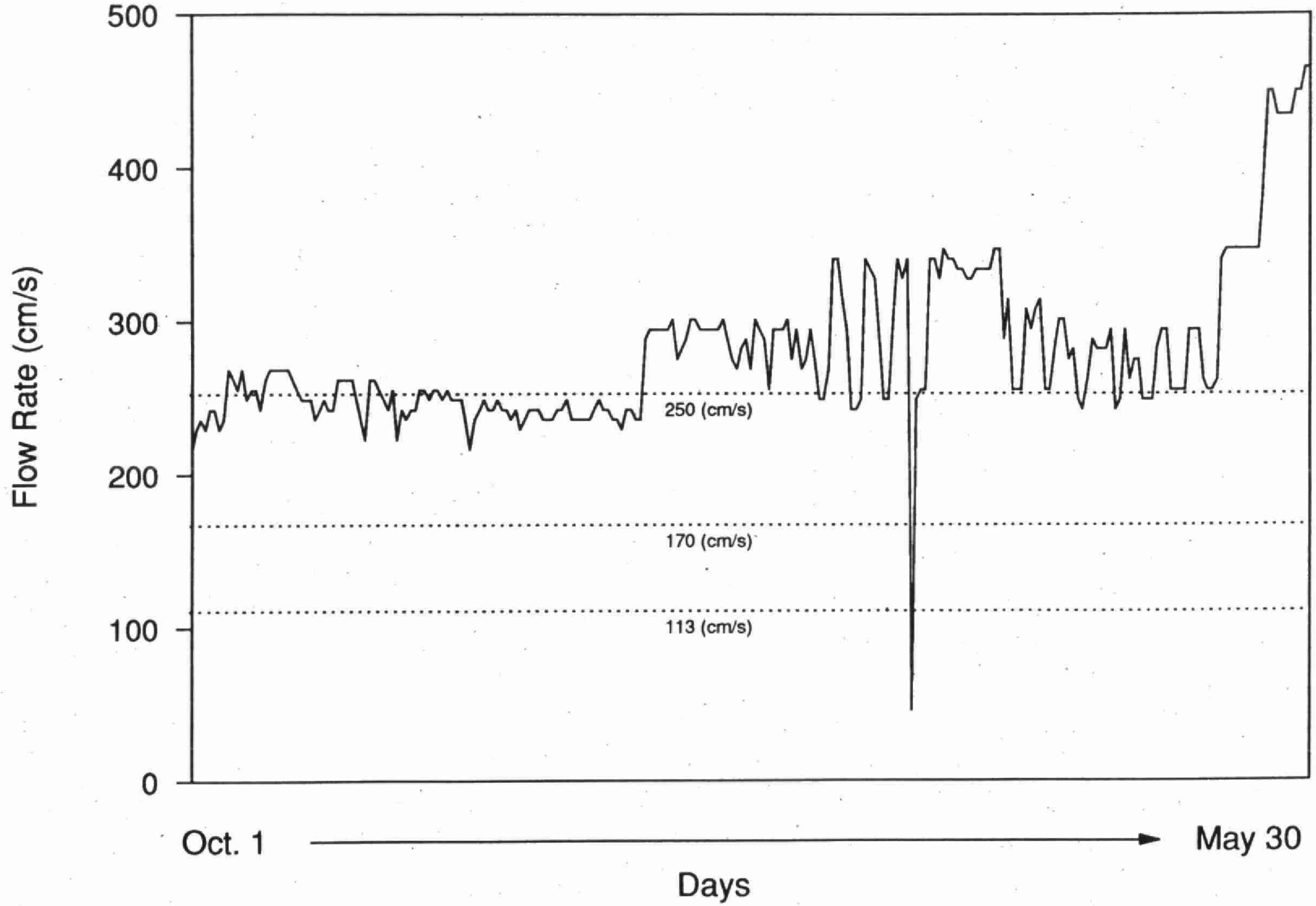
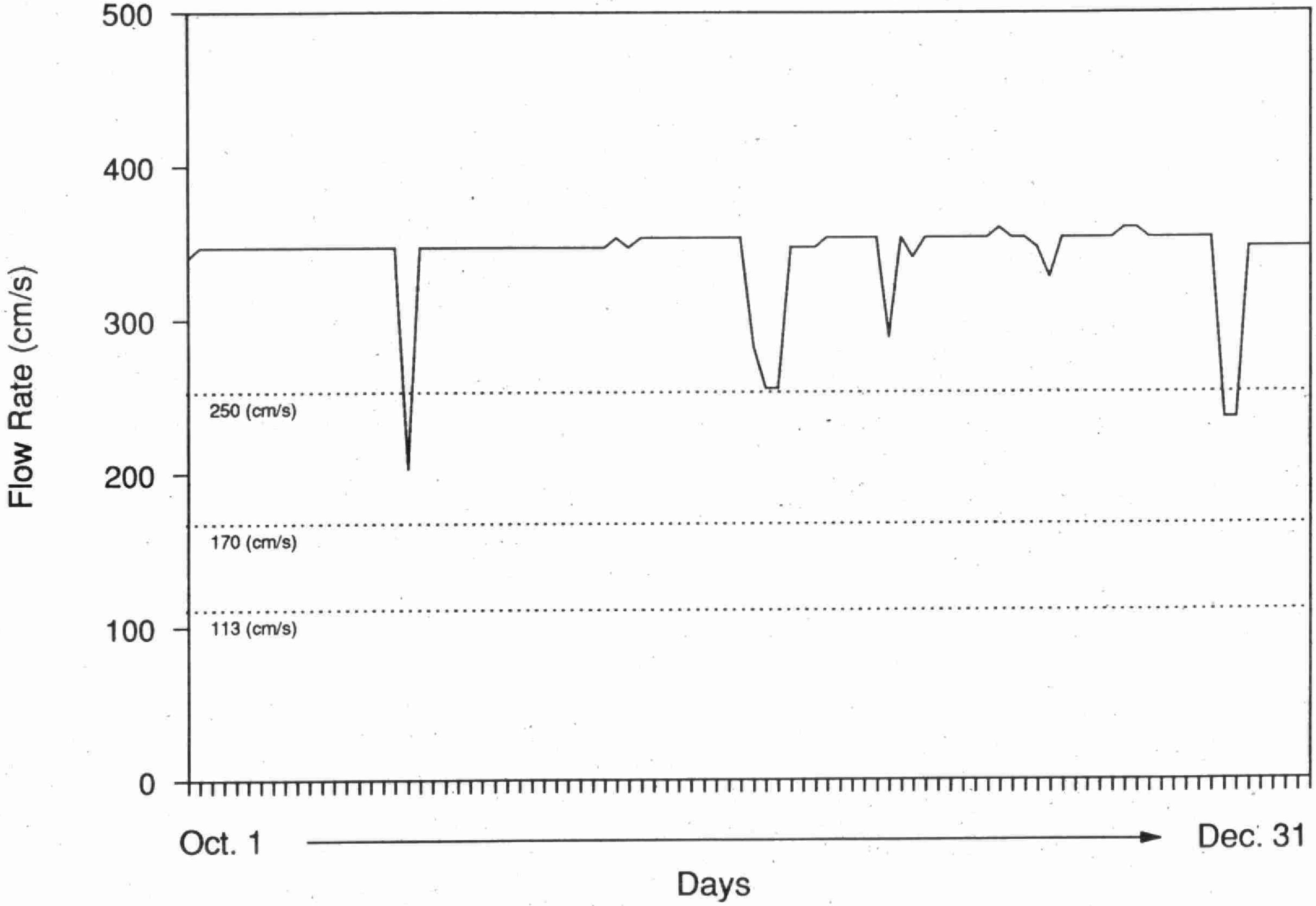


Figure 8: Nipigon River Minimum Daily Flow Rate at Alexander Falls Generating Station Taken from Hourly Measurements: October 1992 through December 1992



Excess water being spilled. Spilled water is measured but is not shown. Flow at times greater than 350 m^3/s.

Appendix 4C

Example of Comparison of Water Level Records at Macdiarmid and Wabinosh

EXAMPLE OF THE COMPARISON BETWEEN DAILY MEAN WATER LEVELS
AT MACDIARMID AND WABINOSH BAY (JAN. 1 1986 TO FEB 24 1986)

MACDIARMID			WABINOSH BAY		
SITE ID	DATE	ELEV	Site ID	Date	HW
798	19860101	260.05	805	19860101	259.99
798	19860102	260.05	805	19860102	259.98
798	19860103	260.08	805	19860103	259.97
798	19860104	260.09	805	19860104	259.96
798	19860105	260.09	805	19860105	259.97
798	19860106	260.09	805	19860106	259.96
798	19860107	260.00	805	19860107	259.96
798	19860108	260.02	805	19860108	259.97
798	19860109	259.99	805	19860109	259.96
798	19860110	260.00	805	19860110	259.97
798	19860111	260.01	805	19860111	259.96
798	19860112	260.04	805	19860112	259.95
798	19860113	259.93	805	19860113	259.93
	N/A		805	19860114	259.93
	N/A		805	19860115	259.92
	N/A		805	19860116	259.93
	N/A		805	19860117	259.93
	N/A		805	19860118	259.92
	N/A		805	19860119	259.91
	N/A		805	19860120	259.90
798	19860121	259.97	805	19860121	259.93
	N/A		805	19860122	259.88
	N/A		805	19860123	259.88
798	19860124	259.93	805	19860124	259.88
798	19860125	259.92	805	19860125	259.92
798	19860126	259.93	805	19860126	259.87
798	19860127	259.92		N/A	
798	19860128	259.92	805	19860128	259.87
798	19860129	259.91	805	19860129	259.86
798	19860130	259.90	805	19860130	259.85
798	19860131	259.90	805	19860131	259.85
798	19860201	259.88	805	19860201	259.85
798	19860202	259.90	805	19860202	259.84
798	19860203	259.88	805	19860203	259.84
798	19860204	259.86	805	19860204	259.84
798	19860205	259.87	805	19860205	259.82
798	19860206	259.86	805	19860206	259.81
798	19860207	259.85	805	19860207	259.81
798	19860208	259.86	805	19860208	259.80
798	19860209	259.85	805	19860209	259.80
798	19860210	259.85	805	19860210	259.79
798	19860211	259.83	805	19860211	259.78
798	19860212	259.83	805	19860212	259.78
798	19860213	259.81	805	19860213	259.78
798	19860214	259.82	805	19860214	259.76
798	19860215	259.81	805	19860215	259.77
798	19860216	259.81	805	19860216	259.76
798	19860217	259.81	805	19860217	259.76
798	19860218	259.79	805	19860218	259.76
798	19860219	259.82	805	19860219	259.75
798	19860220	259.83	805	19860220	259.75
798	19860221	259.78	805	19860221	259.74
798	19860222	259.79	805	19860222	259.74
798	19860223	259.78	805	19860223	259.73
798	19860224	259.78	805	19860224	259.73

Appendix 4D

Excerpt from: Nipigon River Corridor Concept Planning Study
(Moore/George, 1992)

2.0 ARRIVING AT THE TOURISM PLAN

The following chapter discusses the background information which was collected and reviewed during the course of the study and outlines some of the key issues relevant to developing the tourism plan. As well, the public input received during the study has been documented.

2.1 BACKGROUND INFORMATION

During the course of the study a number of activities were undertaken to fully come to terms with the many considerations important to developing an effective tourism plan. Early in the planning process, the consultants made two visits to the study area to become familiar with the potentials of the river corridor and to evaluate the status of existing tourism services. During these visits, boating tours were taken of the Nipigon River between Cameron Falls and Pine Portage, Lake Nipigon, and the Nipigon River from the Township of Nipigon to Lake Superior. A photographic inventory was assembled to record the natural features of the area and for later use as a promotional tool. While in the area, the consultants spent time with local people involved in the tourism sector discussing issues and opinions on the present state of the industry , what needs to be done to improve conditions, changing tourist patterns, services, etc. Providing a wide range of thoughts and ideas, these discussions proved to be most valuable.

This work also included reviewing the previous study - "Nipigon River Corridor Development Study Final Report - December 1990", prepared by ARA Consulting Group assisted by MM Dillon, which concentrated on market assessments and tourism potentials, and provided the consultants with a starting point and an insight into many considerations regarding tourism in the area.

In addition to this work, the Ministry of Natural Resources - Nipigon District - was consulted regarding environmental/bio-physical resource considerations in the study area. The proposed development described in the following chapters does not adversely impact on these resources.

2.2 KEY ISSUES

The time spent in the study area, discussions held with the working group and members of the tourism sector, and the review of the existing conditions suggests there are a number of key issues to be resolved. We have identified and discussed several of these.

- The most important tourism attraction the area has to offer is its landscape. Efforts should be made to protect and preserve its environmental and scenic qualities. Only those uses which are compatible and which do not adversely affect these resources should be encouraged.

- At the present time, tourism opportunities are limited to individual initiatives which tend to serve a specific clientele. Overall services and attractions are fragmented and there is not an organizing body to coordinate and promote tourism in the area.

- There is presently a lack of sufficient food and accommodation services to meet the needs of a diverse tourist population. The existing facilities tend to be similar in nature and do not provide for a variety choice or selection.

- The existing attractions in the area require promotion and advertising to increase traveller awareness. The boat charters available are relatively unknown to the passer-by. The Nipigon waterfront, under development, is unsigned and not identified as an attraction. In this regard, road signs are required to inform and direct potential tourists.

- Access for the tourist to many of the significant natural features of the area is poor. There is no direct boat access to the Nipigon River between Cameron Falls and Pine Portage and in general, the boat charters available in the area cater to a specific clientele and do not provide "walk on" day tours.

- Many of the existing amenities in the area require enhancement to fully capture the opportunities available. For example, the downtown areas of Red Rock and Nipigon require beautification improvements to create a more pleasant pedestrian atmosphere; retail and shopping services need to be expanded; the Nipigon River overlook on Hwy. 17 is essentially undeveloped and requires improvement.

- At present, the tourism season is essentially limited to the summer months. Opportunities need to be made available to encourage tourism throughout the year.

- Ontario Hydro was consulted regarding the proposed transmission line which crosses the Nipigon River. At the present time, their preferred location is between Cameron Falls and Lake Jessie at the river's narrowest point. Consideration must be given to the impact of the proposed transmission line on potential tourism opportunities.

2.3 PUBLIC CONSULTATION

At the conclusion of the second phase of the study, a public meeting was held to receive comments and input into the tourism plan. In general the plan was well received and endorsed by the community. Many of the comments received outlined additional attractions which could be developed. The focus of concern tended to be the support necessary (political, community, business) to implement the plan. The comments received at the public meeting were summarized by the working group and have been reproduced in the following pages.

Comments in Favour:

- entire concept is breathtaking - limitless
- this concept's (tourism coordinating group) promotion of the "Land of Nipigon"
- this plan in general, excellent
- creation of nature trails and walkways, bicycle trails, snowmobile trails, skiing trails uniting Red Rock and Nipigon
- involving Lakehead University in art workshops in the wilderness/poetry, prose workshops/photography seminars/ice climbing/well advertised festivals
- outdoor activities
- anything that will bring tourism to our area
- more signs on the highway - the lack of good signs is pathetic, signage required to promote the area
- improvement of the downtown area - cosmetic changes
- more facilities on the waterfront such as showers and a good restaurant
- more good and informative information about this area (ice festivals at Orient Bay not mentioned in latest brochure)
- some major theme or event for which the area becomes known
- more spirit of entrepreneurship from private sector
- Split Rock development with headquarters at north end of Jessie Lake
- development of area into tourist centre
- use of areas natural attractiveness
- "Bud Car" on rarely used CNR - scenic route Red Rock to Beardmore
- boat rentals and launching on Jessie Lake
- preserve attractions - keep in natural state
- zodiac and boat tours
- incorporate a "most decorated boat" into fall fishing festival
- idea of having the old and wise elderly citizens of this community present their story on the history of Nipigon on tape
- the overall concept - especially the attractions - e.g. Museum and Environment Centre

Comments of Concern:

- availability of financing for investments on property you don't own, where funding will come from
- land acquisition
- liability costs/concerns for tourism/high risk hazard for entrepreneurs
- entrepreneurs that don't cover the entire package - attractions, accommodations, food, etc., may be semi successful but will be dependant on the success of all components before their venture will be truly successful
- lack of concern by Ministry of Tourism and Recreation people
- lack of a centre piece, namely an attractive destination shopping core in Nipigon. To this end, the Business Improvement Group has proposed a two stage plan with Stage 1 - architectural evaluation of the downtown core through the C.A.U.S.E. program. Our approach to municipal council was turned down flat in the fall of 1991. Stage 2 would be a business initiated partnership with the municipality in developing a Business Improvement Area (B.I.A.). The concern of the business community, the Chamber of Commerce, with the backing of M.E.D.A. is that a workable partnership be developed to improve the downtown core.
- the future of our community if we do nothing
- how the M.T.O. 4 lane highway project will affect the highway and businesses located along it. Fixing up an existing operation is one thing but relocating is another ball game altogether
- Nipigon has the highest municipal taxes on the north shore
- targeting European adventurous tourist seeking wilderness experiences
- maintaining the mystique of the Nipigon River area
- timber being cut along the river and close to the lakes
- accommodation and food outlets
- lack of community spirit - the "status quo" seems to be the prevailing theme
- how to get citizens to become more proud of their town and interested in doing what they can to improve it - more people need to be involved - too much of the same people trying to do everything
- CPR trains running through town and blowing the whistle extensively - is this a pro or con for tourists
- lack of tourist souvenir promotion
- more welcoming signs
- over use of waterways by power boats
- diminishing traditional trapping rights
- over-development - concrete, boardwalks

- building permanent log buildings such as river drive camp - waste of tax dollars - Old Fort Williams is a good example of this
- lack of communication between the business of the community and the running of the Tourist Information Centre to promote what our community has to offer
- lack of vision from those who hold the purse strings

Other Suggestions:

- nautical museum
- charters - re: scuba diving
- trails - re: trikes, quadrunners
- rental business - kayaks, canoes, white water rafting
- geological, mining exploration, rock hound exploration
- logging express train tour with casino, honky tonk piano bar
- casino hall
- waterslide at the marina, waterslide park in conjunction with a trailer court (KOA type)
- nature tours
- explore native handcrafts, period village in working order
- annual outdoor craft show/sale showing local crafts - e.g - Muskoka Arts Festival in Bracebridge
- better foot access to salmon fishing below Alexander Dam and possibly a boardwalk along the river to fish from
- Split Rock and Jessie Lake should be brought to M.N.R.'s attention for a provincial park. Almost every other town on the north shore has a provincial park on their doorstep
- the B.I.A. needs to be in on this as they look for a theme for the town
- summer theatre stressing local past and present activities
- band shell in the park/waterfront for summer concerts
- promoting Nipigon and Red Rock as good retirement places
- getting a customs clearance for boating people in Nipigon instead of just Thunder Bay
- tower lookout for view of Nipigon Bay, Red Rock, Lake Helen
- develop Parmachine Ridge, Ruby Lake Palisade (400 ft. high)
- go for it !

Appendix 4E

Comparison of Mean Monthly Water Levels on Lake Nipigon in September and the following May, 1951 to 1990

COMPARISON BETWEEN THE MEAN MONTHLY WATER LEVEL (AT MACDIARMID) IN SEPTEMBER OF A GIVEN YEAR AND MAY OF THE FOLLOWING YEAR

YEAR	SEPTEMBER W.L. (m)	YEAR	MAY W.L. (m)	DIFFERENCE IN W.L. (m)
1951	260.2	1952	259.8	0.4
1952	260.1	1953	259.5	0.6
1953	260.2	1954	260.0	0.2
1954	260.3	1955	259.8	0.5
1955	260.0	1956	259.5	0.5
1956	260.1	1957	259.9	0.2
1957	260.2	1958	259.9	0.3
1958	260.2	1959	259.6	0.6
1959	260.2	1960	259.6	0.6
1960	259.8	1961	259.6	0.2
1961	260.0	1962	259.4	0.6
1962	260.1	1963	259.6	0.5
1963	260.3	1964	259.8	0.5
1964	260.4	1965	259.6	0.8
1965	259.7	1966	259.7	0.0
1966	260.2	1967	259.4	0.8
1967	259.9	1968	259.6	0.3
1968	260.4	1969	259.8	0.6
1969	260.3	1970	259.7	0.6
1970	260.3	1971	259.8	0.5
1971	259.9	1972	259.6	0.3
1972	259.5	1973	259.2	0.3
1973	259.8	1974	260.0	-0.2
1974	260.3	1975	259.8	0.5
1975	260.0	1976	259.5	0.5
1976	259.5	1977	259.0	0.5
1977	259.8	1978	259.6	0.2
1978	260.3	1979	259.7	0.6
1979	260.0	1980	259.6	0.4
1980	259.5	1981	259.3	0.2
1981	259.4	1982	259.2	0.2
1982	259.7	1983	259.5	0.2
1983	259.9	1984	259.7	0.2
1984	260.1	1985	259.6	0.5
1985	260.2	1986	259.8	0.4
1986	260.0	1987	259.4	0.6
1987	259.6	1988	259.3	0.3
1988	260.2	1989	260.0	0.2
1989	260.1	1990	259.7	0.4
1990	260.1	1991	259.6	0.5

Appendix 6A

Determining Optimal Strategies for Multi-Objective Water Resources Systems

Alan A. Smith
(Alan A. Smith Inc.)

A WATERSHED MANAGEMENT PLAN FOR THE NIPIGON RIVER SYSTEM

APPENDIX - A

MODELLING OF CONFLICTING STRATEGIES

Alan A. Smith
(Alan A. Smith, Inc.)

1 INTRODUCTION

Identification of an optimal strategy for the Nipigon River system is made more complicated due to the competing economic and environmental interests. The stakeholders in this study have been identified in the main body of the report but can be summarized briefly as (a) First Nations, (b) power generation, (c) fishing interests, (d) property owners and (e) commercial operations. These various interests are mutually exclusive in that what is good for one stakeholder is bad for one or more of the others. For example, hydro power generation may be most efficient when seasonal storage in Lake Nipigon is maximized by allowing the levels to vary over a wide range. The extreme high and low levels pose inconvenience or danger to other interest groups such as lakeshore property owners (who prefer an average level throughout the year), fish spawning redds (which must remain covered) and boat operators (who suffer losses if levels are too low).

The purpose of the model is to provide a methodology whereby these competing interests can be quantified in manner which allows an optimal operating strategy to be identified which represents a reasonable compromise to all the stakeholders.

The *optimal strategy* will take the form of a suggested sequence of values of discharge and water level which should be maintained in order to achieve this compromise.

Optimization involves the comparison of a very large number of feasible alternatives for which an *objective function* is evaluated. This is simply a measure of the total benefits and costs to all of the stakeholders who are affected by the control of flows and levels in the lake and river system. Ideally, all of the costs or benefits should be expressed in terms of a dollar value so that they can be added together. Unfortunately, many of the interests involve somewhat intangible costs or benefits which makes simple addition impracticable unless certain assumptions are made.

The assumptions required involve placing some relative weight or emphasis on the cost or benefit to the differnet interest groups and experimenting with different weights to see how these affect the best or optimal strategy.

The process of computer modelling involves two stages:-

(1) The first stage defines the penalty functions for each group of stakeholders and allows the user to sum these together in some realistic way with relative weights that can varied easily. The resulting composite penalty terms are written to an interface file which links the two stages of the analysis together.

(2) The second stage starts by reading the data from the interface file. The composite penalty terms are then used as an objective function which is to be minimized by manipulating the levels and flowrates at various discrete locations over different time periods. The optimal strategy is determined by a network analysis program which is a variation of linear programming.

Each of these stages is discussed in more detail below.

2 DEFINITION OF PENALTY TERMS

A computer program is prepared which allows the user to assign different weights (or measures of relative importance) to the various interest groups. The preferences of these interest groups is represented by a penalty function which indicates the value or range of water level (or flow rate) for which no cost or penalty is experienced and the rate at which the expected cost or penalty increases as the water level rises above or falls below the ideal value(s). A typical penalty function is shown in Figure A.1 and shows that during the months from October through May the level in Lake Nipigon should preferably be not less than 258.4 m, that a fall in level of (say) 0.9 m below this value would result in a loss of 30% of fish spawning but a drop of 1.5 m would be disastrous. Such a loss is represented by a cost of 1 or 100%. The actual dollar-value of this cost cannot be assigned accurately and for this reason it is necessary to experiment with different weights relative to the other stakeholders or interest groups.

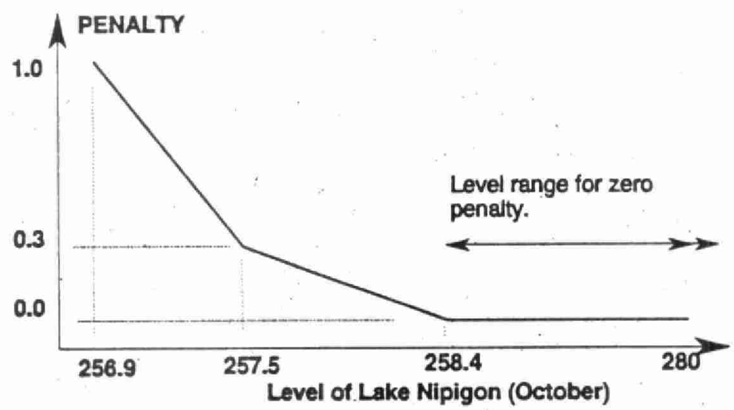


Fig A1 - Typical penalty function for brook trout redds in Lake Nipigon (month of October)

It should be emphasized that in this and the examples which follow the values of Lake elevation are intended for illustrative purposes only. The values used in describing the actual penalty functions will be based on discussion and survey during a later stage in the investigation.

As a second example let us consider the interests of property owners around Lake Nipigon. Very low lake levels can cause inconvenience in loss of access or shallows prohibiting boat access. On the other hand, very high levels can result in loss of beaches and possible erosion damage to property. A typical penalty function to describe these concerns is illustrated in Figure A2.

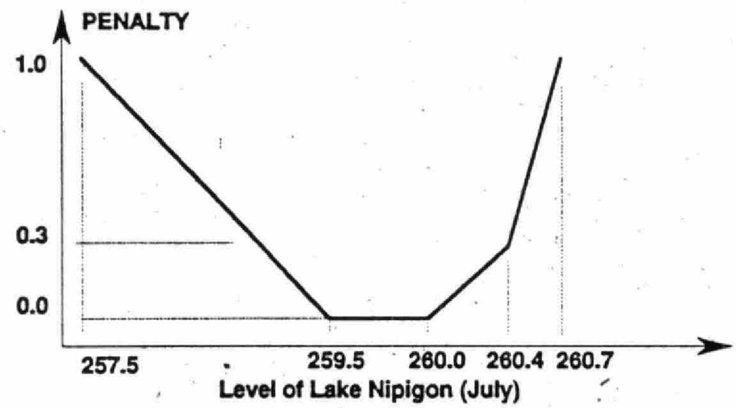


Fig A2 - Possible penalty function for property owners at Lake Nipigon
(month of July)

It is important to note that each of the above examples is for a particular month of the year. More specifically the brook trout spawning constraint will apply from October 1 to May 30 over the winter season. On the other hand, cottage owners on the lake shore are more likely to be concerned about low levels during the summer months although even during fall, unusually high levels may cause damage. The concerns of property owners for the month of October might then result in the modified penalty function of Figure A3.

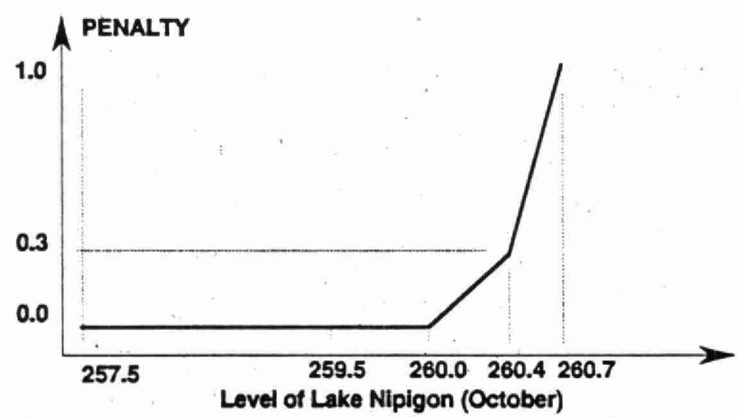


Fig A3 - Modified penalty function for property owners at Lake Nipigon
(month of October)

3 COMBINING PENALTY FUNCTIONS

To illustrate the concept of weighted penalty functions we can examine the combined interests of the Lake Nipigon summer residents and the brook trout spawning redds. Clearly, if we are to combine these we must use penalty decriptions for the same period of time. Let us assume that the penalty functions of Figures A1 and A2 both apply to the month of May which represents the end of the spawning season and the (rather early) start of the cottage season. Let us further assume that the potential value of loss for both these stakeholders is the same. We could then construct a joint penalty function by scaling down both curves by a factor of one half and adding the curves together. This would produce the composite penalty function shown in Figure A4.

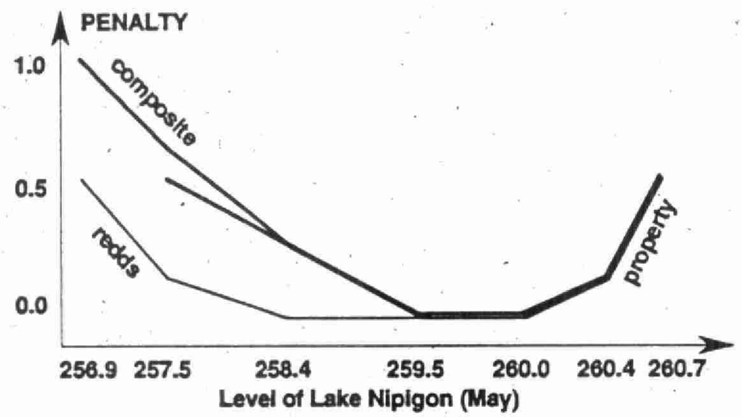


Fig A4 - Composite penalty function for both redds and property owners at Lake Nipigon (month of May)

This example is deliberately simplistic to illustrate the concept of combining penalty functions which may exhibit conflicting preferences. In practice, there are other stakeholders whose interests are more complex and which vary significantly over the year (and in some cases over much shorter time intervals). Finally, we have considered only one location (Lake Nipigon) and one variable (water level) and the entire process must be duplicated for each location of interest between Lake Nipigon and Lake Superior.

We have also made an arbitrary assumption concerning the relative importance of the two stakeholders in this simple example. In order to easily test the effect of varying the relative importance (i.e. the weight) of different stakeholders we require an automatic means of generating the composite penalty functions at every critical location and for each time interval (e.g. month) within the period of analysis. A computer program has been developed which carries out this function and which generates a file of information from which an optimal strategy can be determined.

It should be emphasized that the value of the results obtained in this way is heavily dependant on the accuracy with which the impact of varying flows or levels on the various interest groups can be determined.

4 GENERATING THE INTERFACE FILE

In using the program the user has the opportunity to specify the files to be used, the period of record to be employed in analyzing historic data, and the weights to be applied to the different user-interests. Once a weighted sum penalty function has been obtained for a particular location, it must be approximated by a standard format which typically is represented by a simple, 5-point (i.e. 4 segment) penalty function. An illustration is shown in Figure A5.

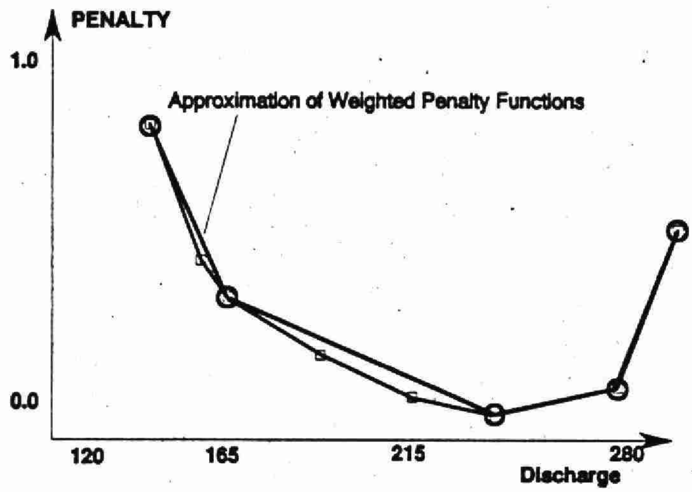


Fig. A5 - Approximation of Weighted Sum of penalty Functions by a 5-Points Function

The procedure used to identify the set of 5 points which best approximates the weighted sum of the penalty functions can be summarized as follows.

(a) Identify the lowest point as point #3 - the middle point.
(b) Identify the extreme points, #1 and #5 as the maximum of the set of lower bounds and the minimum of the set of upper bounds respectively.
(c) Select an internal point #2 such that the root-mean-square of the error between the approximation and the desired function is minimized.
(d) Repeat step (c) to identify internal point #4.

This procedure is repeated for each location and each time step required for the solution. For each iteration the coordinates of the approximated penalty function is written to the interface file with an identifying string.

5 REPRESENTING THE NIPIGON SYSTEM

The drainage of the Nipigon system is quite complex but it can be represented in an idealistic way by the schematic of Figure A6. The given data — i.e. the phenomena which cannot be controlled— are as follows:-

(a) The historical natural inflows from the drainage area plus the flow diversions from the Ogoki River which would otherwise flow east to the Albany River system and thence to Hudsons Bay. ,

(b) The historical water levels in Lake Superior at the downstream limit of the Nipigon River.

The controllable variables are:-

(c) the outflows from Lake Nipigon at the Pine Portage Generating Station.

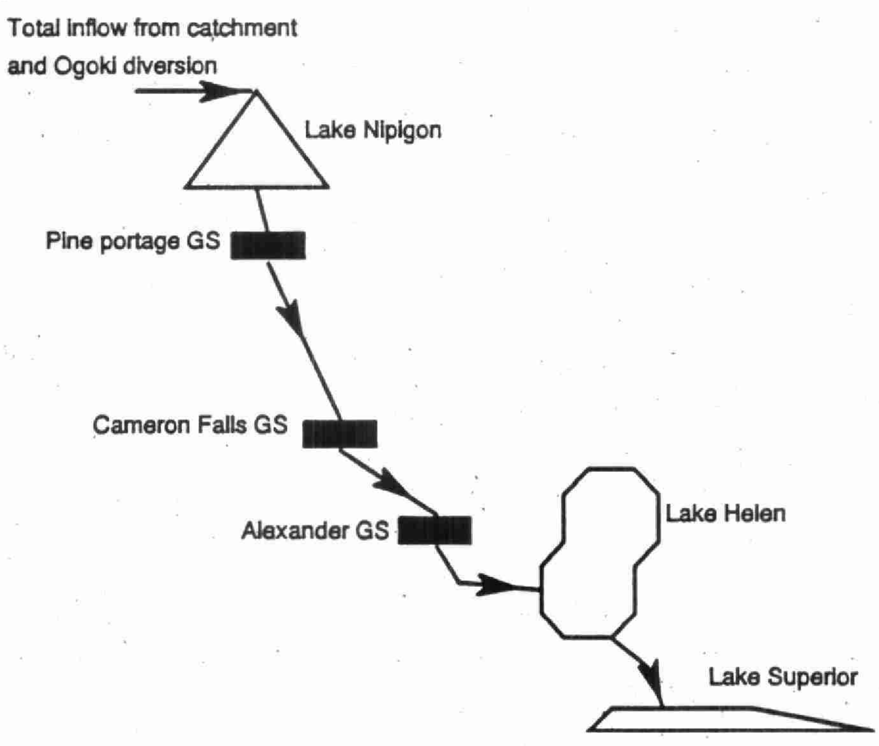


Fig. A6 - Schematic of the Nipigon system

The other variables which are of interest are as follows:-

(i) Water levels in Lake Nipigon
(ii) Flow rates in the Nipigon River upstream of Lake Helen.
(iii) Levels in the Nipigon River upstream of Lake Helen.
(iv) Water levels in Lake Helen.
(v) Outflows from Lake Helen.
(vi) Flow rates in the Nipigon River from Lake Helen to Lake Superior
(vii) Levels in the Nipigon River from Lake Helen to Lake Superior.

All of the variables are linked by the hydraulics of the system, which is characterized by various storage-elevation and stage-discharge curves.

Critical locations are identified at various points in the system where variation of either level or flowrate is likely to have a significant impact on one or more of the stakeholders. At each of these locations penalty functions must be determined for each stakeholder for every time interval in the period of analysis.

Using these penalty functions—developed and combined as described earlier in this Appendix—together with the given data (a) and (b) and the system hydraulic characteristics the optimization model will find the releases at Pine Portage GS that will minimize the total cost or penalty over any time period of interest. This series of releases can then be used to establish operating rules for the generating stations based on the time of year and the elevations in Lake Nipigon and Lake Helen. The optimization process can be repeated for different sets of weighting factors to determine the extent to which the optimal operating strategy is sensitive to the assigned weights.

The analysis described will use relatively large time intervals such as one month. In addition to this long-term analysis it will be necessary to develop an additional model which will examine the effect of variation of flow throughout a 24-hour period to reflect the change in demand for power generated by the system. This model will take a daily flow target for a particular season and examine the impact of various peaking scenarios on the flows and levels throughout the system.

It is important to note the difference in the approach taken by the two models. The optimization model takes the cost or penalty information and tries to identify an optimal strategy (of flow releases) which will minimize the net cost to all of the stakeholders. The peaking model, on the other hand, is a simulation model in that it does not consider the cost or penalty functions, but rather examines the impact on stakeholders oeratioins as a result of adopting a particular flow peaking pattern during a day. The combined results of the two models should allow the identification of a strategy for operating the Nipigon system for the benefit and convenience of all the parties concerned.

Remedial Action Plan
Plan d'Assainissement

Canada Ontario

Canada-Ontario Agreement Respecting Great Lakes Water Quality
L'Accord Canada-Ontario relatif à la qualité de l'eau dans les Grand Lacs